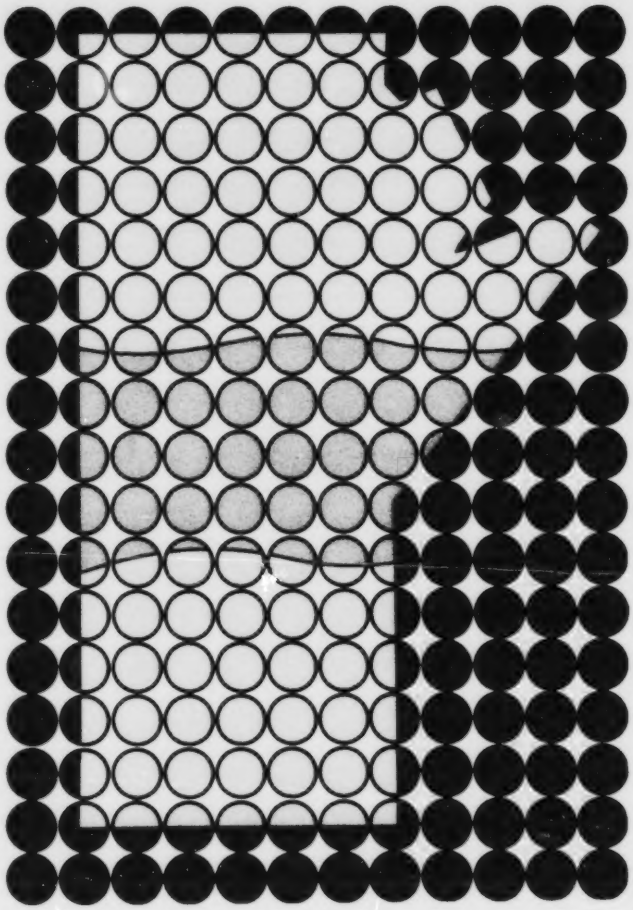

CANADA — MANITOBA Soil Survey

Soils of the South Assiniboine River Study Area

Report D64

Government of Canada / Gouvernement du Canada

Government of Manitoba / Gouvernement du Manitoba

MS 6593 D70

SOILS REPORT NO. D64 1986

Soils of the South Assiniboine River Study Area

by

Glenn Podolsky

CANADA-MANITOBA SOIL SURVEY

AGRICULTURE CANADA

MANITOBA DEPARTMENT OF AGRICULTURE

DEPARTMENT OF SOIL SCIENCE, UNIVERSITY OF MANITOBA

PREFACE

This interim report and map of the detailed field study of the soils of the South Assiniboine River study area are one in a new series of such soil survey reports covering special interest areas in southern Manitoba. These reports reflect the growing concern by various government agencies that support the Canada-Manitoba Soil Survey, that a knowledge of the soils of Manitoba is the key to understanding their properties, behavior and response to management. This concern requires that soils be described both in terms of their basic properties and the nature of the environmental setting in which they are found. Thus, when an area such as that in the South Assiniboine study requires delineation of land of high or low value for crop production or for other uses, the basic reference document is a reliable soil map.

The land resource information included in this resurvey covers approximately 4 095 ha of land southeast of Brandon along the south side of the Assiniboine River. It includes only a fraction of the area covered in the former reconnaissance surveys of the South-Central Map Sheet Area (Report No. 4, 1943) and the Carberry Map Sheet Area (Report No. 7, 1957). However, the projected more intensive use of the soils for agriculture and the growing competition for other uses of land in the area has created a need for more up-to-date, and more detailed soil information. The increased examination of soils in the field, the use of current aerial photography, the use of improved methods of studying soils in the laboratory and the accumulated knowledge of the properties and uses of soils over the years have all contributed to the additional information contained in this new series of reports and maps.

During the course of the resurvey of the study area, a significant volume of site specific data for the soils mapped in the area was generated, that for practical reasons cannot be included in this interim report. These data are currently being input into the Canada Soil Information System (CanSIS) data bank. This computerized system of data management permits automated manipulation and statistical evaluation of large volumes of data for soil characterization and interpretations. These data are available on request. In addition, the cartographic file of CanSIS provides a capability to produce derived maps of various kinds quickly and inexpensively. The types of derived maps that can be generated from the basic soil map include the sixteen interpretations that are provided in tabular form in this report as well as a number of single feature maps for such characteristics as drainage, texture of surface deposits, slope, stoniness, distribution of salinity etc. A package of interpretive maps and single feature derivative maps can also be made available on request to: The Canada-Manitoba Soil Survey, Dept. of Soil Science, Rm. 362, Ellis Bldg., University of Manitoba, Winnipeg R3T 2N2.

The Canada-Manitoba Soil Survey trusts that this report and accompanying map will be of value to all individuals and agencies involved with the use of land within the map area.

ACKNOWLEDGEMENTS

This soil study was conducted as a joint project of the Canada Department of Agriculture, Manitoba Department of Agriculture and the Soil Science Department of the University of Manitoba.

Laboratory analysis were provided by: R. Mirza, K.C. Yeung, E. St. Jacques and J. Madden under the direction of P. Haluschak.

Soil map bases were compiled by the Cartographic Unit of the Land Resource Research Center, Ottawa.

Map compilation and digitization in preparation for publication and addition to the CanSIS cartographic file was capably undertaken by J. Griffiths, R. DePape and M. Brown.

Manuscript review and soil correlation was provided by R.E. Smith.

Final Typing of the report manuscript was provided by Diane Sandberg.

The soils were mapped by Glen Podolsky assisted by John Mazur.

HOW TO USE THIS SOILS REPORT

This soils report contains considerable information about the soils, their origin and formation, their classification and their potential for various uses such as dryland agriculture, irrigation, engineering and recreation. The report is divided into four parts: Part I provides a general description of the area; Part 2 describes the methodology used in the study; Part 3 discusses the development, scientific classification and morphological characteristics of the soils in the study area, and Part 4 provides an interpretation of soil properties and associated landscape features as they affect soil capability or suitability for various uses.

The soil map of the study area is compiled on an uncontrolled air photo base which is included in a pocket of the report folder. The map shows the distribution of soil types and associated landscape features that are significant for potential use as field management units. It provides a linkage from landscapes within the study area to the information contained in the report.

To assist the user in retrieving soil information quickly, the following steps are suggested:

If the project consists of a number of individual maps, proceed with STEP 1., if there is only a single map in the pocket, proceed with STEP 2 to 6.

STEP 1 Consult the index to map sheets <u>if</u> the report contains many maps. Locate the areas of interest and note the map-sheet number(s) which identify their location.

STEP 2 Consult the appropriate soil map in the pocket of the report folder. Locate the area(s) of interest on the map and identify the pertinent map unit symbols. Arabic numerals placed as superscripts following map symbols indicate the approximate proportion of each soil type within the map unit.

STEP 3 Consult the extended legend accompanying the soil map for an alphabetical listing of soil symbols giving the soil name, classification, drainage and related information concerning landforms, nature and depth of materials, and dominant vegetation.

STEP 4 For interpretive information about the soils, consult the appropriate Table in Part 4. Criteria utilized as guidelines in making these interpretations are provided in the Appendix.

STEP 5 Further information concerning the morphological properties and extent of the soils is presented in Part 3 where the soils are described alphabetically according to soil name.

STEP 6 Additional site-specific information not contained in this report is available on request from the Canada-Manitoba Soil Survey, Rm. 362 Ellis Building, University of Manitoba; phone 474-6115 or 474-6118.

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA
JANUARY, 1986

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
Detailed Studies and Surveys								
D1	Pasquia (No. 11)	Pub. 1960	57 200	a,b,d	3	1:63,360	Color	A
D2	Glenlea Research Station	Int. 1963	541	a,b	1	1:7,920	Photo	A
D3	Morden Experimental Farm	Int. 1961	256	a,b	1	1:12,000	Photo	A
D4	Onanole	Int. 1968	768	a,b	1	1:7,920	Photo	U
D5	York Factory Area	Int. 1969	768	a	3	1:63,360	B&W	
D6	McCreary Tile Drain Project	Int. 1971	64	a,b	1	1:5,000	B&W	A
D7	Brandon Experimental Farm	Int. 1985	768	a,b	1	1:7,920	Photo	A
D8	Portage Potato Farm	Int. 1972	480	a,b	1	1:4,800	Photo	A
D9	Portage la Prairie (No. 17)	Pub. 1972	113 200	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D10	Morden-Winkler (No. 18)	Pub. 1973	71 424	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D11	Deep Lake	Int. 1975	1 400	a,b	1	1:6,000	B&W	R
D12	Thompson Environmental Study	Int. 1976	32	a,b	1	1:1,000	B&W	
D13	Organic Soil Study of Alexander L.G.D.	Int. 1975	29 456	a,b	3	1:63,360	B&W	A
D14	Winnipeg Region	Pub. 1975	280 000	a,b,c	2	1:20,000	Photo	A,E,U,R
D15	Brandon Region	Pub. 1976	59 600	a,b,c	2	1:20,000	Photo	A,E,U,R
D16	Boissevain-Melita (No. 20)	Pub. 1978	262 912	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D17	Carman	Pre.	73 905	a,b	2	1:20,000	B&W	A,E,R
D18	Orr Lake	Int. 1977	20	a,b	1	1:1,000	B&W	
D19	Pelican-Rock Lake	Int. 1983	14 080	a,b	2	1:20,000	Photo	A,E,R,I
D20	West Portage	Int. 1982	120 956	a,b	2	1:20,000	Photo	A,I,E,R
D21	Minnewasta	Int. 1978	2 560	a,b	2	1:20,000	Photo	A,E,R,I
D22	Killarney	Int. 1979	4 600	a,b	2	1:20,000	Photo	A,E,R,I
D23	Matlock-Gimli-Riverton	Int. 1981	18 400	a,b	2	1:20,000	Photo	A,E,R,I
D24	Glenboro	Int. 1979	5 960	a,b	2	1:20,000	Photo	A,E,R,I
D25	Sandy Lake	Int. 1980	1 720	a,b	2	1:20,000	Photo	A,E,R,I
D26	Brokenhead	Int. 1979	10 813	a,b	2	1:20,000	Photo	A,E,R,I,U
D27	Rockwood	Int. 1980	12 928	a,b	2	1:20,000	Photo	A,E,R,I,U
D28	Oak Lake	Int. 1979	1 293	a,b	2	1:20,000	Photo	A,I
D29	Bird River	Int. 1980	2 560	a,b	2	1:20,000	Photo	A,E,R
D30	North Shore Lac du Bonnet	Int. 1980	2 400	a,b	2	1:20,000	Photo	A,E,R
D31	Grindstone Point	Int. 1979	8 040	a,b	2	1:20,000	Photo	A,E,R

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1986

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
D32	Paint Lake	Int. 1980	2 880	a,b	2	1:10,000	Photo	A,E,R
D33	Cranberry Portage	Int. 1980	80	a,b	1	1:5,000	Photo	A,E,R
D34	Dauphin	Int. 1981	6 400	a,b	2	1:20,000	Photo	A,E,R,I
D35	South Riding Mtn.	Pre.	23 488	a,b	2	1:20,000	Photo	A,E,R
D36	West Interlake	Int. 1981	10 036	a,b	2	1:20,000	Photo	A,E,I,R
D37	Swan R. Townsite	Pre.	7 680	a,b	2	1:20,000	Photo	A,E,R,I
D38	Hadashville-organic	Int. 1981	6 475	a,b	3	1:40,000	Photo	A,E,I,R
D39	Part of L.G.D. Stuartburn (Rat River)	Pre.	27 972	a,b	3	1:40,000	Photo	A,E,I,R
D40	Falcon L-Brereton L	Pre.	25 900	a,b	2	1:20,000	Photo	A,E,R
D41	Quesnel Lake-North Shore Winnipeg River	Pre.	3 000	a,b	2	1:20,000	Photo	A,E,R
D42	Duck Mountain	Int. 1982	3 036	a,b	2	1:20,000	Photo	A,E,R
D43	Spruce Woods	Pre.	26 300	e	3	1:40,000	Photo	A,E,R
D44	McGregor	Int. 1982	3 910	a,b	2	1:20,000	Photo	A,E,R
D45	Pine Creek	Int. 1983	1 942	a,b	2	1:20,000	Photo	A,E,R,I
D46	Arborg-Riverton	Int. 1982	2 590	a,b	2	1:20,000	Photo	A,E,R,I
D47	Roblin	Int. 1983	4 096	a,b	2	1:20,000	Photo	A,E,R,I
D48	Flin Flon	Pre.	4 600	a,b	2	1:20,000	Photo	A,E,R
D49	St. Anne-La Broquerie	Pre.	74 592	a,b	3	1:40,000	Photo	A,E,R,I
			4 662	a,b	2	1:20,000	Photo	A,E,R,I
D50	City of Brandon	Int. 1984	2 980	a,b	2	1:20,000	Photo	A,E,R,I
D51	Westbourne	Int. 1985	51,456	a,b	2	1:20,000	Photo	A,E,R,I
D52	Notre Dame, Rathwell, Treherne Townsites	Int. 1984	6 144	a,b	2	1:20,000	Photo	A,E,R,I
D53	Altona, Emerson, Gretna, Ile des Chenes, Landmark, Letellier, Rosenort, St. Jean Townsites	Int. 1984	14 080	a,b	2	1:20,000	Photo	A,E,R,I
D54	Russell, Binscarth-Townsites	Int. 1984	3 584	a,b	2	1:20,000	Photo	A,E,R,I
D55	St. Rose Du Lac-Townsite	Int. 1985	1 536	a,b	2	1:20,000	Photo	A,E,R,I
D56	Souris, Wawanesa, Virden, Townsites	Int. 1986	6 400	a,b	2	1:20,000	Photo	A,E,R,I
D57	Fraserwood, Inwood, Komarno Townsites, Lake Man. Shoreline	Pre.	1 856	a,b	2	1:20,000	Photo	A,E,R,I
D58	Hallboro, Minnedosa-Townsites	Int. 1984	4 544	a,b	2	1:20,000	Photo	A,E,R,I
D59	Beaudry Park	Data	640	a,b	2	1:20,000	Photo	A,E,R
D60	Portions of Dufferin, Grey, and Roland	Data	68 488	a,b	2	1:20,000	Photo	A,E,R,I
D61	Meditation Lake	Data	3 072	a,b	2	1:20,000	Photo	A,E,R
D62	Wanipigow Lake	Data	8 960	a,b	2	1:20,000	Photo	A,E,R

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1986

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
D63	Shellmouth Resevoir-N	Data	4 650	a,b	2	1:20,000	Photo	A,E,R,I
D64	Assiniboine River	Pre.	4 095	a,b	2	1:20,000	Photo	A,E,R,I
D65	Villages of Hamiota, Strathclair, Rapid City, Newdale, Birtle, Shoal Lake	Pre.	5 180	a,b	2	1:20,000	Photo	A,E,R,I
D66	Springfield R.M.	Pre.	13 440	a,b	2	1:20,000	Photo	A,E,R,I
D67	St. Eustache, Springstein, Perimeter Strip, Brunkild, La Salle R.	Pre.	6 200	a,b	2	1:20,000	Photo	A,E,R,I
D68	Spruce Point Mine Area	Pub.	450	a,b	2	1:10,000	Photo	E,R
D69	Snow Lake	Data						
Reconnaissance Surveys								
R1	South Western (No. 3)	Pub. 1940	709 600	d	3	1:125,000	B&W	A
R2	South Central (No. 4)	Pub. 1943	967 600	d	3	1:125,000	B&W	A
R3	Winnipeg and Morris (No. 5)	Pub. 1953	1 419 200	d	3	1:125,000	Color	A
R4	Rossburn and Virden (No. 6)	Pub. 1956	1 372 400	d	3	1:125,000	Color	A
R5	Carberry (No. 7)	Pub. 1957	967 600	d	3	1:125,000	Color	A
R6	West-Lake (No. 8)	Pub. 1958	592 800	d	3	1:125,000	Color	A
R7	Grandview (No. 9)	Pub. 1957	689 200	d	3	1:125,000	Color	A
R8	Nelson River Basin (No. 10)	Pub. 1973	224 000	b	3	1:100,000	Color	A
R9	Fisher and Teulon (No. 12)	Pub. 1961	949 200	a,c	3	1:100,000	Color	A
R10	Swan River (No. 13)	Pub. 1962	316 000	a,c	3	1:125,000	Color	A
R11	South Eastern (No. 14)	Pub. 1964	749 200	a,c	3	1:125,000	Color	A,F
R12	Lac du Bonnet (No. 15)	Pub. 1967	764 800	a,c	3	1:125,000	Color	A,F,R
R13	Grahamdale (No. 16)	Pub. 1971	764 800	a,b	3	1:125,000	Color	A,F,U,R,E
R14	Red Rose-Washow Bay (No. 19)	Pub. 1975	704 400	a,b	3	1:125,000	Color	A,F
R15	Boissevain-Melita (No. 20)	Pub. 1978	299 520	a,b	2	1:40,000	Photo	A,I,E
R16	Ste. Rose (No. 21)	Pub. 1981	676 705	a,b	3	1:125,000	Color	A,I,R,E,F
R17	Waterhen (No. 23)	Pub. 1985	949 600	a,b	4	1:125,000	B&W	A,I,R,E,F
R18	Swan Lake	Data	599 200	a,b	3,4	1:125,000	B&W	A
R19	The Pas (No. 22)	Pub. 1982	791 700	a,b	4	1:125,000	Color	A,I,E,R,F
R20	Grand Rapids	Pre.	675 031	a,b	4	1:125,000	B&W	A
R21	Cormorant	Int. 1975	920 000	a,b	4	1:125,000	B&W	A
R22	Wekusko	Pre.	1 400 000	a,b	4	1:125,000	B&W	A
R23	Pointe du Bois	Data	740 000	a,b				
R24	Roseau River	Pub. 1977	45 200	a,b	3	1:63,360	B&W	A
R25	Red Deer Lake	Pub. 1966	34 860	a,b	2	1:31,680	Photo	A
R26	Cross Lake and Norway House	Pre.	615 200	a,b	4	1:125,000	B&W	A
R27	South Central - Escarpment	Pre.	107 744	a,b	2,3	1:40,000	Photo	A,E,R
R28	Pasquia Lake	Pub. 1984	2 330	a,b	3	1:50,000	B&W	A,E
R29	Lorne R.M.	Pre.	512	a,b	2	1:20,000	Photo	A,E,R,I
			4 608	a,b	2	1:20,000	Photo	A,E,R,I
			73 728	a,b	3	1:50,000	N.T.S.	A,E,R,I

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1986

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
R30	Benito	Pre.	18 432	a,b	3	1:50,000	Photo	A,E,R,I
R31	R.M. Woodlands	Pre.	9 980	a,b	3	1:50,000	Photo	A,E,R,I
R32	Whitemouth Peatland		10 240	a,b	3	1:50,000 1:125,000		
R33	R.M. Rockwood							
R34	R.M. South Norfolk	Pre.	7 936	a,b	3	1:50,000	N.T.S.	A,E,R,I
			2 304	a,b	2	1:20,000	Photo	A,E,R,I

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1986

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
Biophysical and Exploratory Surveys								
B1	Lake Winnipeg, Churchill & Nelson Rivers	Pub. 1973	3 600 000	e	4	1:250,000 1:50,000	B&W	
B2	Churchill Transportation Corridor	Data 1974	179 000	f	4	1:125,000	B&W	
B3	54C Hayes River	Int. 1976	1 370 300	f	4	1:125,000	B&W	
B4	54D Kettle Rapids	Int. 1976	1 370 300	f	4	1:125,000	B&W	
B5	52M Carrol Lake	Int. 1977	634 000	f	4	1:125,000	B&W	
B5	62P Hecla	Int. 1977	466 200	f	4	1:125,000	B&W	
B6	53D Deer Lake	Int. 1978	629 700	f	4	1:125,000	B&W	
B6	63A Berens River	Int. 1978	848 500	f	4	1:125,000	B&W	
B7	53M Knee Lake	Int. 1978	1 405 900	f	4	1:125,000	B&W	
B8	53L Oxford House	Int. 1978	1 441 100	f	4	1:125,000	B&W	
B8	63H Norway House	Data	540 800	f	4	1:125,000	B&W	
B9	SE 1/4 64A Split Lake	Int. 1979	342 400	f	4	1:125,000	B&W	
B9	63P Sipiwesk	Int. 1979	1 405 900	f	4	1:125,000	B&W	
B10	53E Island Lake	Pre.	1 286 900	f	4	1:125,000	B&W	
B11	63H Norway House	Data				1:125,000	MSS	
E1	Surface Deposits & Soils of Northern Manitoba	Int. 1963		g	5	1:1,267,000	B&W	
E2	Exploratory Terrain Study of Northern Manitoba and Southern Keewatin, N.W.T.	Int. 1974		g	5	1:1,000,000	B&W	

1. Report Status
   Pub.-Published Report and Map
   Int.-Interim Report and Map Available
   Pre.-Preliminary Map and Legend Available
   Data-Field Data Available Only

2. Map Unit Descriptions Code
   a-single series and phases
   b-series complexes defined as to proportion
   c-series complexes undefined as to proportion
   d-associations
   e-biophysical units (materials and physiography)
   f-biophysical units (associations & complexes of associations)
   g-regional and local physiographic units

3.Survey Intensity Levels

Code	Name	Scale	Minimum Size Delineation(ha)	Inspection Density (Approx. range)
1	Very detailed	>1:12,000	<1.5	>1 per 3 ha
2	Detailed	1:12,000 to 1:40,000	1.5-16	1 per 3 to 50 ha
3	Semi-detailed	1:40,000 to 1:125,000	16 to 256	1 per 10 to 1 000 ha
4	Reconnaissance	1:125,000 to 1:250,000	256 to 625	1 per 100 to 110 000 ha
5	Exploratory	1:250,000 to 1:1,000,000	625 to 110 000	1 per 300 to 500 000 ha

4.Published Map Base Code

Photo-Photomosaic
B&W -Black and white line
Color-Colored line

5.Interpretations Code

A-Agriculture Capability
E-Engineering
F-Forestry
I-Irrigation Suitability
U-Urban Planning and Community Development
R-Recreation

TOTAL HECTARAGE COVERED

	1985	To Date
Initial Reconnaissance	---	18,619,436
Initial Detailed survey	1,554	18,014
Detailed Resurvey	123,029	1,970,192
Biophysical Survey	---	12,521,000

Published Reports, Maps, Interim Reports, available at a cost of $2.00 per copy (except for D20) from:

Queen's Printer,
Publications Branch,
Manitoba Archives Bldg.,
200 Vaughan St.,
Winnipeg, Manitoba R3C 1T5
Phone:945-3103

Detailed Surveys of Winnipeg Region and Brandon Region available at a cost of $6.00 each from:

Municipal Planning Branch
Manitoba Dept. of Municipal Affairs
1418-405 Broadway Ave.,
Winnipeg, Man., R3C 3L6
Phone: 945-2150

Biophysical Land Classification Maps and Reports a ailable at a cost of $3.50 each from:

Surveys and Mapping Branch
Century Industrial Branch
989 Century Plaza
Winnipeg, Man., R3H OW4
Phone: 945-6666

Preliminary Map and other field data available from:

Canada-Manitoba Soil Survey Office,
Rm. 362 Ellis Bldg., University of Manitoba
Winnipeg, Man., R3T 2N2
Phone: 474-6115 or 474-6118

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PART 1

GENERAL DESCRIPTION OF THE STUDY AREA

1.1 LOCATION AND EXTENT

The South Assiniboine Study is located southeast of Brandon along the southern edge of the Assiniboine River, extending from an area north of Treesbank to camp Kiche Manitou north of Glenboro Figure 1. The study encompasses 4 095 hectares of land within the Rural Municipality of South Cypress.

The project is a resurvey of a small portion of the area formerly covered in the reconnaissance survey of the Carberry Map Sheet Area (Report No. 7, 1957) and the South-Central Area (Report No. 4, 1943) at a scale of 1:125,000. The current resurvey was carried out at a scale of 1:20,000. The eastern boundary of the study interfaces with the "Soils of the Glenboro Area, D24" and the "Soils of the Spruce Woods Provincial Park, D43" projects. A Summary of soil survey coverage for Manitoba is provided in Table 1.

1.2 LAND USE

The present land use throughout the study area is primarily agriculture. The crops grown are largely cereal grains as well as corn, flax, canola and sunflowers. Livestock and grain production are combined on a number of mixed farms. The cultivated lands are largely the finer textured loam to clay loam soils whereas the native grazing and pasture occupy the coarser sandy soils and eroded slopes.

The outdoor recreational resources of the area are abundant. The presence of trails, undisturbed natural vegetation and complex topography in the sand dune areas of the study provide an ideal setting for hiking, riding, cross country skiing and snowmobiling. The Assiniboine River itself supports such activities as fishing, boating, canoeing and swimming. Of particular historical interest in the study area is the presence of the Stockton and Treesbank ferries which are still in operation and are used to cross the Assiniboine.

1.3 GEOLOGY

The geological features of the study area are outlined in Figure 2. The entire study area is underlain by bedrock of the Upper Cretaceous Period within the Mesozoic Era. More specifically, included here are the bentonites and shales of the Vermilion River Formation.

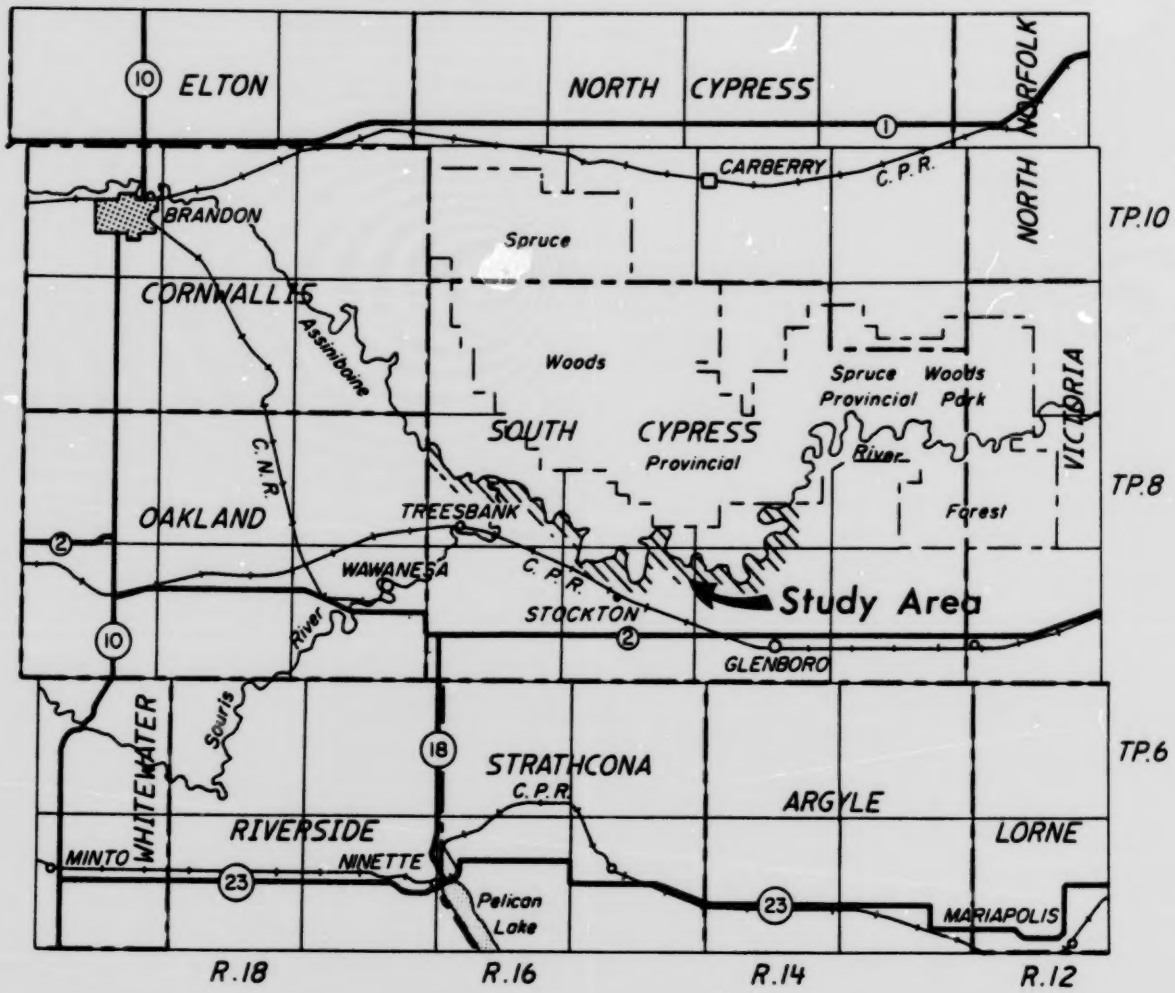
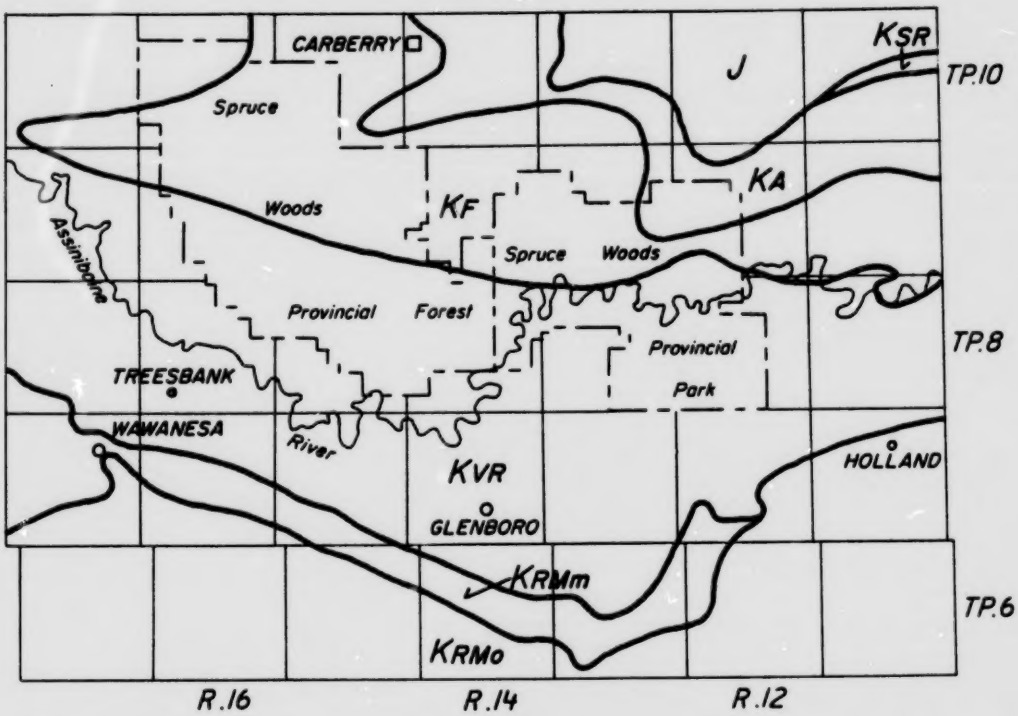


Figure 1: Location of Study Area.



MESOZOIC

Upper Cretaceous

KRM^{m}_{o} — Riding Mountain Formation: Millwood Member (m) – soft greenish bentonitic shale. Odanah Member (o) – hard grey siliceous shale.

KVR — Vermilion River Formation: Morden Member – black carbonaceous shale. Boyne Member – grey calcareous speckled shale and carbonaceous. Pembina Member – thinly interbedded carbonaceous shale and bentonite.

KF — Favel Formation: calcareous speckled shale, minor limestone, bentonite.

Upper and Lower Cretaceous

KA — Ashville Formation: dark grey carbonaceous shale, minor sand and silt.

Lower Cretaceous

KSR — Swan River Formation: sandstone, kaolinitic shale, minor lignite.

Jurassic

J — Amaranth Formation: red argillaceous dolomitic siltstone and sandstone overlain by gypsum or anhydrite. Reston Formation: limestone and dolomite, shale interbeds. Melita Formation: fine-grained sandstone, variegated shale, minor limestone.

Figure 2: Geology.

1.4 RELIEF AND DRAINAGE

The elevation of the study area, ranges from a low of 1050 f.a.s.l. (320 m.a.s.l.) along the Assiniboine at the eastern edge to a high of 1200 f.a.s.l. (365 m.a.s.l.) at a distance from the river, and generally increases to the west (Figure 3). The greatest change in relief is confined to the steep river channel walls which may have a vertical change of up to 100 ft. (30 m) and the bench or step-like scarp faces bordering the terraces. The regular sequence of low relief undulations (scrolls), resulting from progressive river meanders range from very gently to gently sloping (2-9%). The lacustrine and upper plain terrace areas are predominantly level to very gently sloping. The eolian landforms of the study area exhibit a hummocky surface expression with slopes ranging from 2 to 45%.

The major drains or waterways in the area are the Assiniboine River and its contributory Souris River. These rivers in addition to a number of smaller drains, ditches and channels facilitate the drainage of the area. The overall drainage of the area is fairly well developed with a few exceptions. The alluvial oxbows of the lower floodplains have a ponding or standing water problem for a majority of the growing season. A noteworthy occurrence along the Assiniboine River valley walls is the presence of major seepage zones. These occur in both straight sections and in semi-circular incisions or "punch bowls" where the original groundwater table intersects the escarpment. A number of seepage zones also emerge at the base of the alluvial terraces which represent a large part of the study area.

1.5 PHYSIOGRAPHY

The distribution of physiographic divisions as related to the study area are shown in Figure 4. The study occurs almost entirely within the Upper Assiniboine Delta subsection of the Assiniboine River Plain section with a minor portion in the Brandon Lakes Plain subsection.

The physiography is characterized by a level to undulating deltaic-lacustrine plain, local sand dune areas and a level to undulating glaciofluvial plain. In addition, a large U-shaped Assiniboine River meltwater channel with its corresponding steep dissected banks, river terraces, floodplains and alluvial bottomlands, constitute a significant part of the study area.

1.6 SURFACE DEPOSITS

The range and depth of materials throughout the study are closely related to the mode of deposition and position in the landscape. The deposits of the lower floodplain consist of scrolled alluvium that is dominantly loamy textured. Small areas of sandy point bar deposits also occur along the inside curve of the meanders. The soils of the mid to upper alluvial terraces are largely loam to silty clay loam textured and frequently have fluvial sands and gravels at or below 1 metre, particularly at the upper levels.

At a greater distance beyond the alluvial terraces are the deep lacustrine deposits. Included here are either sandy deltaic deposits or finer textured (L-CL) lacustrine sediments overlying sandy deltaic deposits. In contrast, the southeast part of the study is an eolian landform with deep sand dune deposits.

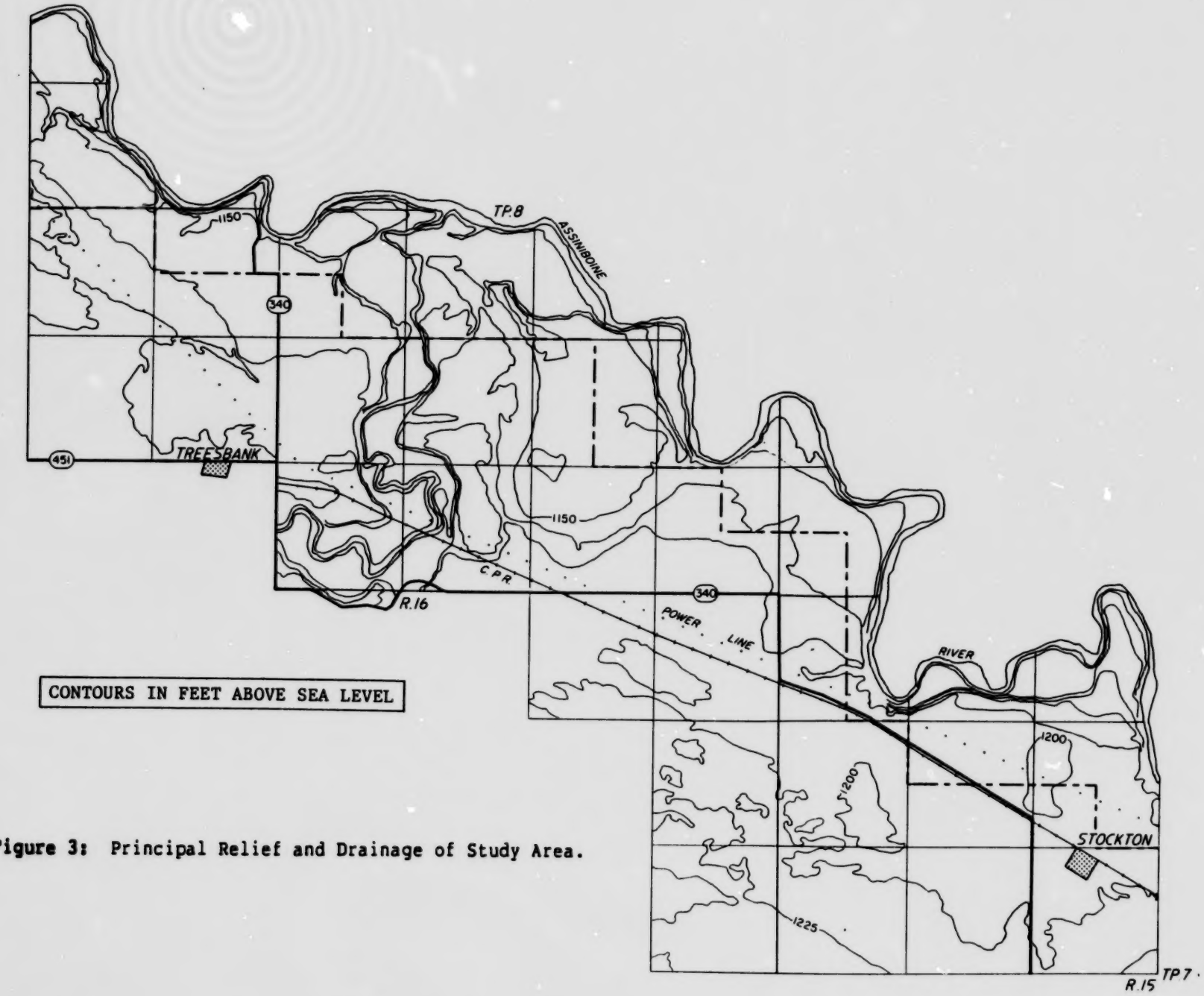
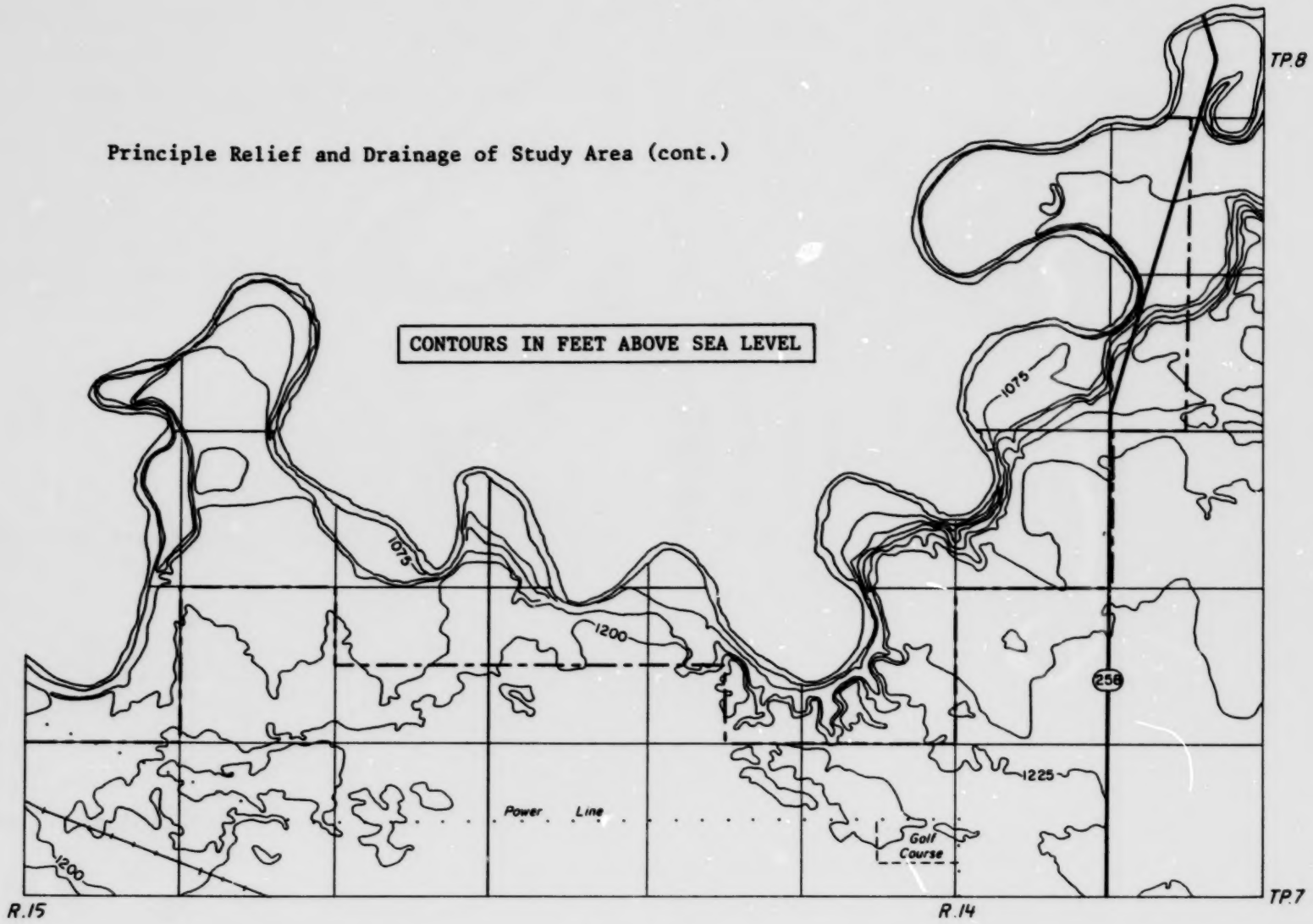
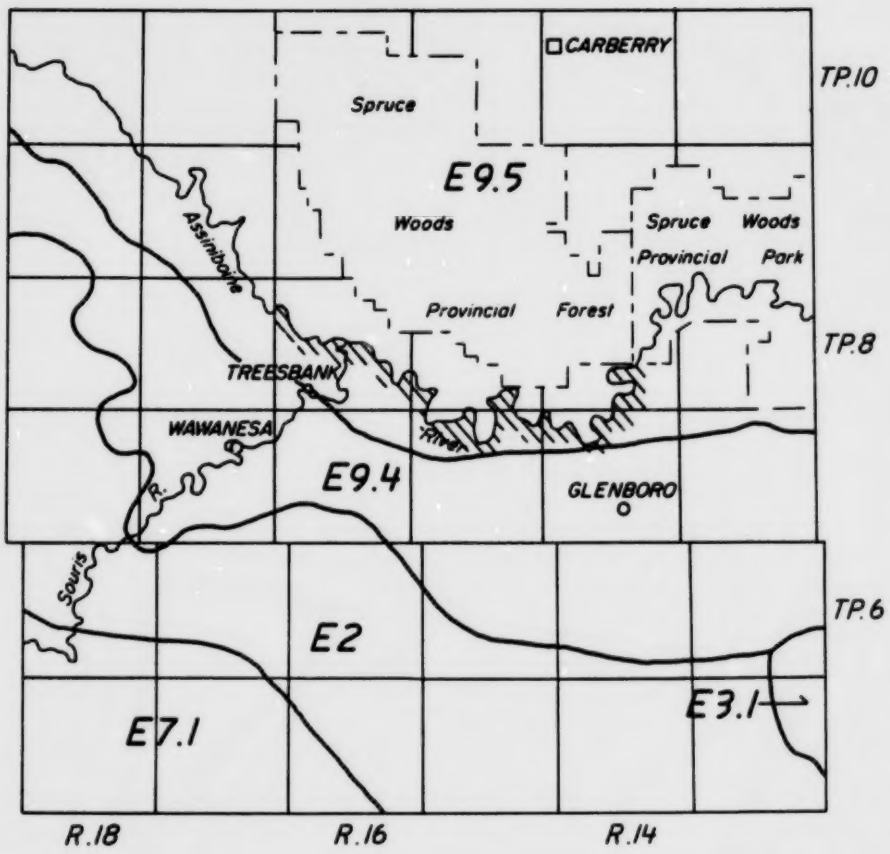


Figure 3: Principal Relief and Drainage of Study Area.

Principle Relief and Drainage of Study Area (cont.)





DIVISION	SECTION	SUBSECTION
E Saskatchewan Plain	E2 Tiger Hills Upland	
	E3 Pembina Hills Upland	.1 Pembina Hills
	E7 Pembina River Plain	.1 Boissevain Plain
	E9 Assiniboine River Plain	.4 Brandon Lakes Plain
		.5 Upper Assiniboine Delta

Figure 4: Physiographic subdivisions in the Study Area.

1.7 CLIMATE

In relation to worldwide climatic conditions, the South Assiniboine area is within the region described by Koppen as Dfb, which is dominantly cool, subhumid continental (Koppen, 1936). Due to its location in the center of the continent, a great distance from the moderating effect of the oceans, summer temperatures are higher, winter temperatures are lower and the annual temperature range is much greater than the world average for the same latitude.

The meteorological station at Glenboro is the closest long term recording station to the study area (A.E.S. 1982). The data comprises normals based on the period 1951 to 1980. The mean annual air temperature is 2.4°C with July being the warmest month at average temperatures of 19.2°C and January the coldest at -18.6°C. The annual total precipitation for the area is 523.3 mm with July being the wettest month at 96.5 mm and December the driest at 20.5 mm.

Various other climatic parameters are also of significance to agriculture. The average length of the frost free period above 0°C is 110 days with May 27 being the average date of occurrence of the last spring frost and Sept. 15 the average date of occurrence of the first fall frost. The average length of killing frost free period based on -2.2°C is estimated to be 135 days for the area. The growing degree days above 5.5°C, which provide an indication of heat accumulation for crop growth, are calculated to be 1600. The average accumulated number of corn heat units for the area is 2350.

Relative to the rest of Manitoba the study area lies entirely within the (Gt_2) Grassland Transition Ecoclimatic Region (Ecoclimatic Regions of Manitoba, Canada Manitoba Soil Survey, 1985. Unpublished data, revised, 1987) Figure 5. The corresponding soil climate of the area is classified as subhumid, cool Boreal. This is an area characterized by a mean annual soil temperature between 5.5°C to less than 8.0°C and a mean summer soil temperature of 12 to <16°C based on soil temperatures measured at a depth of 50 cm.

1.8 VEGETATION

The South Assiniboine study area lies almost entirely within the Mixedwood Section of the Boreal Forest Region of Canada as delineated by Rowe, 1972[1]. The western boundary of the study area borders the Aspen-Oak Section. The native vegetation on the terraces and floodplains is composed mainly of poplar, maple, elm, birch and ash with an understory of alder, dogwood and cranberry. Willow, grasses, cattail and sedges dominate the poorly drained oxbows. On the higher positions and somewhat drier sites, oak, spruce, hazel, pincherry, saskatoon and chokecherry are present. The contrasting sand dune area in the eastern part is characterized by stands of white spruce and scrubby oak. Scrub aspen groves occur in local depressions. Sparse grass, artemisia, cactus, creeping juniper, snowberry and ground cedar are common on arid duned sites.

Although the native vegetation has been largely modified and disturbed by man's activities, remnants of the native cover still exist, particularly along the terrace scarp faces, eroded slopes, ravines and duned areas.

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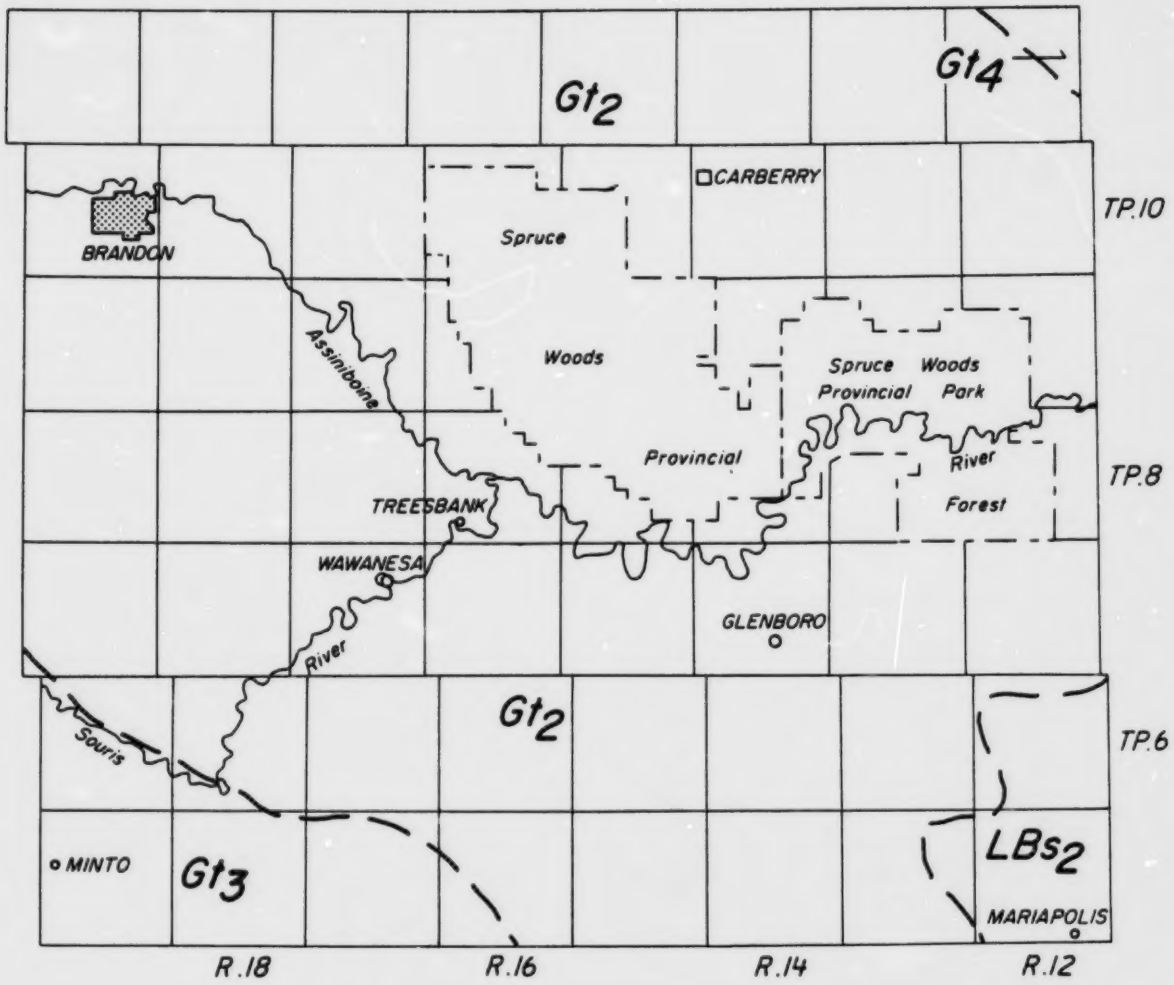
[1] Rowe, J.S. 1972. Forest Regions of Canada. Publication No. 1300, Department of the Environment, Canada Forestry Service, Ottawa.



REGION NAME	SUBREGION SYMBOL	SOIL CLIMATE		DOMINANT SOIL ORDERS	VEGETATION ZONES
		TEMPERATURE CLASS	MOISTURE SUBCLASS		
Low Boreal - Subhumid	LBs_2	Cryoboreal, moderately cold to Boreal, cool	Subhumid to subaquic	Chernozemic (Dark Grey), Brunisols, Organic	Grassland - forest transition
Grassland Transition	Gt_2	Boreal, cool	Subhumid	Chernozemic (Black), Gleysols	Grassland and Aspen Parkland
	Gt_3	Boreal, moderately cool to cool	Subhumid	Chernozemic (Black), Gleysols	Grassland and Aspen Parkland
	Gt_4	Boreal, moderately cool	Subhumid	Chernozemic (Black), Gleysols	Grassland and Aspen Parkland

Figure 5: Climate of Study Area.

PART 2

METHODOLOGY

2.1 MAPPING

Soil mapping in this project was conducted by soil surveyors employing an intensive grid or systematic sampling method. Soil profiles were examined to a depth of one meter at sites approximately 150 meters apart along foot traverses that, in turn, were spaced approximately 0.8 km apart. In this project, the initial inspection point in each section was located 50 to 100 meters from a road allowance fence approximately 0.4 km from a selected corner of the section to be surveyed. The direction each traverse took was determined on the basis of maximizing the information that could be derived from the range of known soil-landscape variations in each section. Additional sites along road allowances were also examined to help locate soil boundaries between sections. This method of sampling provided approximately 25 to 30 inspection sites per section, or put another way, each site represented approximately 8 to 10 ha. This intensity of sampling permitted the confident delineation of soil mapping units comprised of narrowly defined soil types and other landscape features such as slope, stoniness and erosion on maps at a scale of 1:20 000 (3 inches equal one mile).

2.2 MAP UNITS

A map unit represents mappable portions of the soil landscape that together have characteristics and properties varying within more or less narrow limits that are determined by the intensity of the survey. A map unit contains predominantly one or more than one soil or non-soil individual plus a certain proportion (varying within prescribed limits) of unnamed and undescribed inclusions. They are delineated on the basis of the types and relative proportions of their soils or non-soils, as well as on the basis of external criteria such as slope, stoniness or erosion.

Soil maps show the distribution of kinds of soils and, as such, serves as a link so that the knowledge gained in one locality about the usefulness or behavior of a kind of soil can be extended to other bodies of the same soil.

A map unit is named from its principal component soils or non-soils. It is described in terms of the properties of these components, their relative proportions and other external land attributes. In this project, units are described in terms of named soil series and phases of soil series.

Map units will always contain at least small proportions of inclusions. These inclusions may be soil or non-soil mapping individuals that are named and have their own map units elsewhere in the survey, or they may be rare or insignificant

soils or non-soils that are not recognized and named at all in the survey. They may, however, be mentioned in the description of soil types in the report.

2.3 SIMPLE AND COMPOUND MAP UNITS

There are two major types of map units: simple and compound. The difference between them is defined in terms of the proportion and contrast of their components.

A Simple Map Unit contains predominantly one soil or non-soil such as bedrock outcropping. The proportion of its components vary from those that are comprised of at least 65 percent of the predominant type leaving up to 35 percent of similar but non-limiting components to at least 85 percent of the predominant type having up to 15 percent of strongly contrasting, limiting

A Compound Map Unit contains predominantly two soils or non-soils (or a combination of the two). The proportion of the two major components may vary from one considerably exceeding the other to both being about equal. If the components are similar and non-limiting, no single component represents more than 65 percent or if they are dissimilar and more limiting, no single component represents more than 75 percent, or if dissimilar and limiting, no single component represents more than 85 percent. Components of mapping units are considered dominant if they occupy over 40 percent of the unit, significant from 15 to 40 percent, and minor if they occupy less than 15 percent. Minor components are described only if they are highly contrasting.

Compound units are employed in mapping complex soil landscapes where dissimilar soils occur in very intricate patterns and in such small segments that it is not practical to delineate them separately on the map.

Very often, it is desirable to indicate by map unit symbol, minor variations in certain intrinsic properties of soils or landscape features that deviate from the normal. These variants or phases of series usually affect soil management. In this study, the effect of four such properties and features are indicated. These are erosion, slope class, degree of stoniness and salinity. The degree or magnitude of each is designated in the following manner:

Erosion

- x - none-eroded or minimal
- 1 - weakly eroded
- 2 - moderately eroded
- 3 - severely eroded
- O - overblown

Slope Class

- x - 0 to 2% level to nearly level
- c - 2 to 5% very gently sloping
- d - 5 to 9% gently sloping
- e - 9 to 15% moderately sloping
- f - 15 to 30% strongly sloping
- g - 30 to 45% very strongly sloping
- h - 45 to 70% extremely sloping

Stoniness

- x - non stony
- 1 - slightly stony
- 2 - moderately stony
- 3 - very stony
- 4 - exceedingly stony
- 5 - excessively stony

Salinity

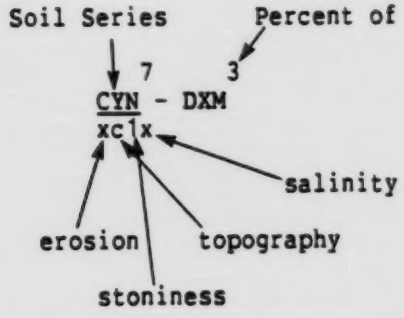
- x - non saline (0-4 mS/cm)
- s - slightly saline (4-8 mS/cm)
- t - moderately saline (8-15 mS/cm)
- u - strongly saline (>15 mS/cm)

The convention employed to indicate these features in the map symbol is as follows:

If none of the above properties are observed to be significant, the map symbol representing the normal or unaffected soil series is used alone without modifiers.

If one or more phase features are recognized, the appropriate letter or number is placed below the soil series symbol in one of four designated locations in the map unit symbol. The designated order is erosion, slope class, stoniness and salinity. If a particular feature is not observed to be significant, an x is used in its appropriate designated location in the map symbol.

For example, the compound map unit coded:



Is interpreted to mean that 70 percent of the mapping unit consists of Croyon (CYN) series, having minimal or no erosion (x), very gently sloping (c) topography, slight (1) stoniness, no salinity (x); and 30 percent Druxman (DXM) series having no or minimal phase features.

Definitions of the erosion, topography, stoniness and salinity classes are given in the Glossary.

2.4 SAMPLING

During the course of field investigations and mapping, soil samples were taken at selected locations for soil characterization, salinity and irrigation suitability studies. In areas where salinity was suspected to be a problem, soils were sampled at 10 to 25 cm and at 50 to 60 cm for electrical conductance measurements and soluble salt analysis.

PART 3

DEVELOPMENT, CLASSIFICATION AND MORPHOLOGY OF SOILS

3.1 SOIL DEVELOPMENT

The principle factors affecting soil formation are climate, vegetation, parent material, relief and drainage. The type of soil formed at any one place is dependent upon the interaction of these factors, the length of time they have been operative, and the influence of human activity.

In the South Assiniboine study area, the degree of soil development is related to the regional climate which affects the degree of leaching, translocation, and accumulation of soluble and colloidal fractions of the soil. The soils have developed under a cool, subhumid Boreal climate which generally provides sufficient moisture and length of growing season for development of aspen-oak groves, tall prairie grasses and associated grassland vegetation. Because of these factors, the dominant soils in this area are Chernozemic Blacks on the well and imperfectly drained positions and Humic Gleysols in the poorly drained positions. Cumulic Regosols occur on the alluvial soils adjacent to the Assiniboine River and comprise a significant portion of the study area. These materials may exhibit varying degrees of profile development, particularly on the better drained mid to upper terrace positions. The feebly developed soils of the sand dunes in the study are classified as Orthic Regosols.

3.2 SOIL SERIES DESCRIPTIONS

The soil series mapped in the South Assiniboine study are described in alphabetical order giving generalized morphological descriptions including name, genetic profile type, texture, parent material, topography and drainage. For additional information and discussion relative to the study area, particularly chemical and physical soil analysis, refer to the "Soils of the Brandon Region Study Area", Report No. 30, 1976 and the "Soils of the City of Brandon Area", Report No. D50, 1984. A convenient, abbreviated form of reference on the relationship of soil series in the study area to the soil moisture class, subgroup and parent material is provided in Table 2. A more comprehensive grouping of soils and parent materials is presented in Table 3.

Table 2. Soil Series of the South Assiniboine Study Arranged in Relation to Soil Moisture Class, Subgroup and Parent Material.

Soil Moisture Class	Subgroup	Parent Materials				
		Outwash	Lacustrine Over Outwash			Eolian
		Sandy (CS,S) to Sandy Skeletal (Gr, GrS)	Sandy (FS,LFS,LS)/ Sandy Skeletal	Coarse Loamy (VFS, LVFS,FSL,SL)/ Sandy Skeletal	Loamy (L,CL,SiCL)/ Sandy Skeletal	Sandy (FS,LFS,LS)
Well	Orthic Regosol Cumulic Regosol Orthic Black Calcareous Black Rego Black	Dorset(DOT)	Wheatland(WHL)	Miniota(MXI)	Croyon(CYN)	Shilox(SHX)
Imperfect	Gleyed Cumulic Regosol Gleyed Black Gleyed Rego Black				Druxman(DXM) Capell(CXT)	
Poor	Rego Humic Gleysol				Carvey(CAV)	

Table 2. cont'd

Soil Moisture Class	Subgroup	Parent Materials						
		Lacustrine					Alluvium	Undifferentiated
		Sandy (FS,LFS, LS)	Fine Loamy (CL,SiCL, SCL)	Fine Loamy (CL,SiCL,SCL)/ Sandy (FS,LFS,LS)	Loamy (L,SiL, VFSL)/Sandy (FS,LFS,LS)	Clayey (C, SiC,SC)	Loamy (FSL, VFSL,L, SiL,SiCL,CL) Stratified	
Well	Orthic Regosol Cumulic Regosol Orthic Black Calcareous Black Rego Black	Arizona(AIZ) Stockton(SCK)	Ramada(RAM)	Wellwood(WWD)	Glenboro(GBO)	Janick(JIK)	Mowbray(MOW)	Eroded Slopes Complex (ERX)
Imperfect	Gleyed Cumulic Regosol Gleyed Black Gleyed Rego Black	Lavenham(LVH) Hummerston(HMO)	Charman(CXV) Prodan(PDA)	Oberon(OBR) Crookdale(CKD)	Grover(GRO)	Harding(HRG)	Levine(LEI)	
Poor	Rego Humic Gleysol	Sewell(SEE)	Tadpole(TDP)				Basker(BKR)	

TABLE 3

Parent Materials and Related Soils of the South Assiniboine Study Area

A. Deep Outwash

1. Soils developed on deep (>1 m) moderately to strongly calcareous, stratified, medium sand and gravel, sandy skeletal, fluvial outwash or beach deposits. These deposits are derived from shale, limestone and grantic rock origin.

   a) Well drained

      • Dorset series (Orthic Black) DOT

B. Shallow Lacustrine Overlying Outwash

1. Soils developed on a thin mantle (<1 m) of moderately to strongly calcareous, sandy (FS, LFS, LS) lacustrine sediments overlying moderately to strongly calcareous, medium sand to gravelly deposits.

   a) Well drained

      • Wheatland series (Orthic Black) WHL

2. Soils developed on a thin mantle (<1 m) of moderately to strongly calcareous, coarse loamy (VFS, LVFS, FSL, SL) lacustrine sediments overlying moderately to strongly calcareous, medium sand to gravelly deposits.

   a) Well drained

      • Miniota series (Orthic Black) MXI

3. Soils developed on a thin mantle (<1 m) of moderately to strongly calcareous, loamy (L, CL, SiCL) lacustrine sediments overlying moderately to strongly calcareous, medium sand and gravel, fluvial deposits.

   a) Well drained

      • Croyon series (Orthic Black) CYN

   b) Imperfectly drained

      • Druxman series (Gleyed Black) DXM

      • Capell series (Gleyed Rego Black, carbonated) CXT

c) Poorly drained

- Carvey series (Rego Humic Gleysol, carbonated) CAV

C. Eolian

1. Soils developed on deep (>1 m) weakly to noncalcareous, sandy (FS, LFS, LS) eolian sediments.

a) Well drained

- Shilox series (Orthic Regosol) SHX

D. Deep Lacustrine

1. Soils developed on deep (>1 m) weakly to moderately calcareous, sandy (FS, LFS, LS) deposits.

a) Well drained

- Arizona series (Orthic Regosol) AIZ
- Stockton series (Orthic Black) SCK

b) Imperfectly drained

- Lavenham series (Gleyed Black) LVH
- Hummerston series (Gleyed Rego Black) HMO

2. Soils developed on deep (>1 m) strongly to very strongly calcareous, fine loamy (CL, SiCL, SCL) lacustrine deposits.

a) Well drained

- Ramada series (Orthic Black) RAM

b) Imperfectly drained

- Charman series (Gleyed Black) CXV
- Prodan series (Gleyed Rego Black) PDA

c) Poorly drained

- Tadpole series (Rego Humic Gleysol) TDP

3. Soils developed on a thin mantle (<1 m) of moderately to strongly calcareous, fine loamy (CL, SiCL, SCL) lacustrine sediments overlying moderately calcareous, sandy (FS, LFS, LS) sediments.

a) Well drained

- Wellwood series (Orthic Black) WWD

b) Imperfectly drained

- Oberon series (Gleyed Black) OBR
- Crookdale series (Gleyed Rego Black) CKD

4. Soils developed on a thin mantle (<1 m) of moderately to strongly calcareous, loamy (L, SiL, VFSL) lacustrine sediments overlying moderately calcareous, sandy (FS, LFS, LS) lacustrine sediments.

a) Well drained

- Glenboro series (Orthic Black) GBO

b) Imperfectly drained

- Grover series (Gleyed Rego Black) GRO

5. Soils developed on deep (>1 m) moderately to strongly calcareous, clayey (C, SiC, SC) lacustrine sediments.

a) Well drained

- Janick series (Orthic Black) JIK

b) Imperfectly drained

- Harding series (Gleyed Black) HRG

E. Alluvium

1. Soils developed on deep (>1 m) moderately to strongly calcareous, stratified, loamy (FSL, VFSL, L, SiL, SiCL, CL) sediments.

a) Well drained

- Mowbray series (Cumulic Regosol) MOW

b) Imperfectly drained

- Levine series (Gleyed Cumulic Regosol) LEI

c) Poorly drained

- Basker series (Rego Humic Gleysol) BKR

F. Undifferentiated

1. Soils developed on eroded slopes and channels with wide ranging properties.

- Eroded Slopes Complex ERX

Arizona Series (AIZ)

The Arizona series consists of moderately well to excessively drained Orthic Regosol soils on weakly to moderately calcareous sandy (FS-LFS, LS) textured lacustrine and deltaic deposits. These soils occur in association with Stockton (Orthic Black) soils and occupy the upper slope and knoll positions. They are the severely eroded Stockton soils. All of the original dark Ah and B horizons of this former Chernozemic Black soil have been removed by wind erosion. These soils have rapid permeability and moderate to moderately rapid runoff and tend to be very droughty.

The soil is characterized by a 10 to 15 cm gray to light gray plow layer and a light yellowish brown to very pale brown C horizon.

Basker Series (BKR)

The Basker series consists of poorly to very poorly drained Rego Humic Gleysol, carbonated soils developed on moderately to strongly calcareous, stratified dominantly loamy (FSL, VFSL, L, SiL, SiCL) recent alluvial sediments. They occur as bottom lands adjacent to stream channels and are subject to flooding and are saturated for a considerable period of time in the spring or following heavy rains. They are closely associated with the imperfectly drained Levine series. The native vegetation consists of dominantly sedges, rushes and willow.

The profile is characterized by a thin layer (3 to 5 cm) of moderately decomposed organic material, and an olive brown to light yellowish brown weak Ahg or Ckg horizon with iron stains. The subsoil is stratified and may have thin organic layers indicating former surfaces. The soil colors are olive to pale yellow and may have some iron mottles in the sandy strata. Basker soils are more permeable than the very similar Kerran series.

Capell Series (CXT)

The Capell series consists of imperfectly drained Gleyed Rego Black (carbonated) soils developed on a thin mantle (< 1 m) of moderately to strongly calcareous loamy (L, SiL, CL, SiCL) sediments overlying moderately to strongly calcareous medium sand to gravelly textured deposits. These soils occur on level to very gently sloping topography or on the lower slope positions on undulating topography. The soils have moderate permeability in the upper sediments and rapid permeability in the lower coarser sediments, but restricted during periods of subsoil saturation due to a perched condition or high water level. In some areas, where the water contains appreciable soluble salts, a sufficient concentration of salts may occur to inhibit or retard the growth of grasses or cereals.

The soil is characterized by a very dark gray to black Ahk horizon 15 to 24 cm thick, a dark gray to gray AC horizon 5 to 15 cm thick, and a lime accumulation horizon 8 to 12 cm thick that extends to or into the coarser materials. Brownish yellow mottles are common in the coarser sediments below. Capell soils have less permeable surface layers than the very similar Kilmury series.

Carvey Series (CAV)

The Carvey series consists of poorly drained Rego Humic Gleysol (carbonated) soils developed on a thin mantle (< 1 m) of moderately to strongly calcareous loamy (L, SiL, CL, SiCL) sediments overlying moderately to strongly calcareous, medium sand to gravelly textured deposits. They occur in level to depressional sites which have a water table at or near the surface for part of the year. They occur in close association with the imperfectly drained Capell and Druxman series and the well drained Croyon series. Runoff is negligible; permeability of the loamy sediments is moderate to moderately slow above the saturation zone. In areas where the seepage water contains soluble salts, a sufficient concentration of salts may occur in the soil to inhibit the growth of native sedge and meadow grasses. They are less permeable than the very similar, coarser Bornett series.

Charman (CRV)

The Charman soil is a Gleyed Black soil developed on imperfectly drained, strongly to very strongly calcareous, fine loamy (CL, SiCL) lacustrine deposits. This soil occurs above the escarpment on level to very gently sloping topography in areas where the water table is often within a meter of the surface associated with Ramada, Carroll, Prodan and Tadpole soils. Surface runoff is slow. Permeability is moderate, but can be restricted due to saturation of the subsoil. In areas of seepage or discharge, soluble salts in the subsoil and groundwater can be translocated nearer the surface in quantities sufficient to affect crop growth.

The Charman soil profile has a very dark gray to black Ah horizon, 15 to 25 cm thick; a dark grayish brown Bmgj horizon, 12 to 30 cm thick; a thin transitional BC horizon approximately 5 cm thick, and a pale brown, silty textured, erosive Ckgj horizon with yellowish brown iron mottles. A light gray Cca horizon of lime accumulation is usually present. Also, gypsum crystals frequently occur below the Cca horizon in some areas. This soil differs from the similar Prodan series in that it has a prominent Bmgj horizon and is free of calcium carbonate in its solum.

Crookdale Series (CKD)

The Crookdale series consists of imperfectly drained Gleyed Rego Black soils developed on a thin mantle (<1 m) of strongly calcareous clay loam to sandy clay loam sediments grading to moderately calcareous sandy deposits. They occur on level to very gently sloping topography. Runoff is moderate to moderately slow; permeability is moderate in the upper loamy strata and moderately rapid in the sandy subsoil when not restricted by a high water table in early spring and summer.

The soil is characterized by a very dark gray to black Ah horizon, 15 to 20 cm thick and a weakly mottled gray to dark gray horizon 5 to 10 cm thick.

A lime carbonate horizon Cca is usually present. The subsoil is olive brown to light olive brown with yellowish brown mottles. This soil differs from the very similar Prodan series in that it has a sandy substratum.

Croyon Series (CYN)

The Croyon series consists of moderately well to well drained Orthic Black soils developed on a thin mantle (< 1 m) of moderately to strongly calcareous loamy (L, SiL, CL, SiCL) lacustrine sediments overlying moderately to strongly calcareous medium sand to gravelly textured deposits. The soil occurs in the mid and upper slope positions of gently undulating to undulating topography in close association with the imperfectly drained Druxman and Capell soils and the poorly drained Carvey soils. The runoff is moderately rapid; permeability is moderate to moderately rapid in the upper sediments and very rapid in the lower, coarser sediments.

The soil is characterized by a very dark gray to black Ah horizon 20 to 30 cm thick, a dark brown Bm horizon 10 to 18 cm thick, a brown to dark brown BCk horizon 5 to 10 cm and a yellowish brown, stratified, loose Ck horizon. Croyon soils have surface layers that are less permeable, hold more water and are less droughty than the very similar Miniota soils.

Dorset Series (DOT)

The Dorset series consists of moderately well to well drained Orthic Black soils, developed on moderately to strongly calcareous, stratified outwash and glaciofluvial deposits of medium sand to gravelly texture. These soils occur on gently sloping to irregular, gently rolling topography in close association with Marringhurst soils. On the complex topography, they occur as a complex with other soils. Runoff is moderate to moderately rapid; permeability is very rapid.

The soil is characterized by a very dark gray Ah horizon, 12 to 18 cm thick and a brown to dark brown Bm horizon (BA and Bm), 15 to 22 cm thick. The Cca horizon is 6 to 12 cm thick. These soils differ from the Marringhurst which has carbonates present in the Ah and Bm horizons. Dorset soils are more permeable and droughty than the very similar Wheatland soils.

Druxman Series (DXM)

The Druxman series consists of imperfectly drained Gleyed Black soils developed on a thin mantle (<1 m) of moderately to strongly calcareous loamy (L, SiL, CL, SiCL) sediments overlying moderately to strongly calcareous medium sand to gravelly textured deposits. These soils occur in gently sloping to level topography. They have a high water table during the spring and early summer. Runoff is moderately slow; permeability is moderate in the upper loamy sediments, and rapid in the coarser sediments below, when not restricted by a high water table.

The soil is characterized by a very dark gray Ah horizon 15 to 24 cm thick, a dark yellowish brown to olive brown Bmgj horizon with yellowish brown mottles; the depth of solum depends on the depth of the loamy sediments, with the Bmgj or BC terminating at the contact of the underlying coarser textured sediments. A lime accumulation horizon is often present at or immediately below this contact. The Druxman series differs from the very similar Capell series in having an Ah and Bmgj horizon free of lime carbonate. These soils are also less permeable than the coarser textured Wytonville soils.

Eroded Slope Complex (ERX)

This soil complex includes all the land occupied by the eroded slopes of river valleys and walls, incised stream channels and ravines that have down-cut through the surface deposits and shale bedrock. These are generally well drained, strongly to steeply sloping landforms that have variable soil development on materials that are variable in composition, depending on the nature of the surrounding deposits. Due to its complexity, this is a miscellaneous land type rather than a unit of normal soil. These areas are typically influenced by mass wasting processes such as slump, creep, solifluction and erosion.

In the study area the soils range from Orthic Blacks to Regosols. The materials are largely deep lacustrine, fluvial and eolian which are subsequently deposited as colluvium along the slopes. Shale bedrock is exposed in the mid to lower slope positions. The slopes are characterized by numerous major seepage zones where the water table intersects the slope walls or scarps, generally in the mid to lower slopes. Seepage areas often take the form of semicircular "punch bowl" type emergence patterns. The maintenance of vegetation on the Eroded Slopes is essential for their stability.

Glenboro Series (GBO)

The Glenboro series consists of moderately well to well drained Orthic Black soils developed on a thin mantle (<1 m) of moderately to strongly calcareous loamy (VFSL, L, SiL) sediments grading to moderately calcareous sandy (FS, LFS, LS) deposits; stratified sands to loams may occur in the transition to the fine sand subsoil. The soils occur on a gently sloping to gently undulating topography. Runoff is moderately slow; permeability is moderate in the loamy sediments and moderately rapid in the underlying sandy sediments.

The soil is characterized by a granular very dark gray to black Ah horizon 12 to 18 cm thick; a subangular blocky dark brown to brown Bm or Btj horizon, 10 to 16 cm thick; a brown to pale brown BC, 6 to 14 cm thick grades into a light gray to very pale brown lime accumulation horizon. The underlying sandy sediments are pale brown to light yellowish brown. A few strong brown to reddish yellow mottles may be present between the 75 to 100 cm depth.

Grover Series (GRO)

The Grover series consists of imperfectly drained Gleyed Rego Black carbonated soils developed on a thin mantle (<1 m) of moderately to strongly calcareous loamy (VFSL, L, SiL) sediments grading to moderately calcareous sandy (FS, LFS, LS) deposits. The soil occurs in a level to gently sloping topography. Runoff is moderately slow to slow; permeability is moderate with some restrictions in the subsoil during periods of high water table.

The soil is characterized by a very dark gray Ah horizon, 10 to 15 cm thick, a dark gray to dark grayish brown ACk horizon, 4 to 8 cm thick, and a lime accumulation layer.

Harding Series (HRG)

The Harding series consists of imperfectly drained Gleyed Black soils developed on moderately to strongly calcareous, silty clay to clay lacustrine deposits. These

soils occur on level to very gently sloping topography. Runoff is slow; permeability is moderately slow to slow. Most of these soils occur within a discharge region characterized by an upward pressure of groundwater or a lateral flow of water through the underlying very strongly calcareous till which may occur at a depth of one to two meters. Appreciable soluble salts may be present within the rooting zone and gypsum crystals are common.

The soil is characterized by a very dark gray Ah horizon 12 to 22 cm thick, a dark grayish brown, prismatic to subangular blocky Bmgj horizon, 15 to 20 cm thick with fine yellowish brown mottles; a lime accumulation horizon is common. Salt pseudomycelium and gypsum concretions are common in the olive brown to olive Ckgj horizon.

Hummerston Series (HMO)

The Hummerston series is a carbonated, Gleyed Rego Black soil developed on imperfectly drained, weakly to moderately calcareous, sandy (FS, LFS, LS) lacustrine and fluvial sediments. The surface texture ranges from loamy fine sand to loamy very fine sand. These soils occur above the escarpment within the Brandon Lakes Plain and Upper Assiniboine Delta in association with Stockton, Lavenham and Sewell soils. Topography is level to gently undulating and runoff is moderately slow. Permeability is moderately rapid, but some impediment to downward movement of water can occur during the spring and early summer due to a high water table. Wind erosion has caused some surface damage to these soils.

The Hummerston soil profile has a very dark gray Ah horizon, 15 to 20 cm thick; a dark gray ACk horizon, 10 to 18 cm thick, and a yellowish brown Ckgj horizon with prominent mottles. This soil differs only slightly from the similar Lavenham series in not having a prominent Bmgj horizon.

Janick Series (JIK)

The Janick series consists of well to moderately well drained Orthic Black soils developed on deep (>1 m) moderately to strongly calcareous silty clay to clay lacustrine deposits. These soils occur on a nearly level to gently undulating topography in the mid and upper slope positions. Permeability is slow; runoff is moderately slow.

The soil profile is characterized by a very dark gray to black Ah horizon 10 to 18 cm thick, a dark grayish brown to brown, fine subangular blocky Bm horizon 8 to 15 cm thick and a pale brown BCk horizon. The C horizon is light grayish brown to pale brown. Some mottles and duller colors occur below the 75 cm depth.

Lavenham Series (LVH)

The Lavenham series is a Gleyed Black soil developed on imperfectly drained, weakly to moderately calcareous, sandy (FS, LFS, LS), lacustrine sediments. These soils occur in the Upper Assiniboine Delta on level to very gently sloping topography, in association with Stockton, Cactus, Hummerston and Sewell soils. Surface runoff is slow, and permeability is moderately rapid. Downward movement of water is restricted in the subsoil during periods of high water table. The water table ranges from 1 meter shortly after spring runoff, to 3 meters below the surface in late fall and winter. These soils are also susceptible to erosion.

The Lavenham soil profile has a very dark gray to very dark brown Ah horizon, 18 to 25 cm thick; a dark brown to yellowish brown Bmgj horizon, 20 to 40 cm thick, with distinct brown mottles in the lower part of the horizon; a lime carbonate accumulation (Ccagj) horizon, 12 to 20 cm thick, and a pale brown Ckgj horizon with distinct to prominent brown mottles. This soil profile differs from the very similar Hummerston soil series in having a prominent Bmgj horizon. Lavenham and Hummerston soils are coarse textured and more permeable than the finer textured Gateside and Pleasant soils.

Levine Series (LEI)

The Levine series consists of imperfectly drained Gleyed Cumulic Regosol soils developed on moderately to strongly calcareous, stratified, dominantly loamy (L, SiL, VFSL, FSL, CL, SiCL) recent alluvial deposits. They occur as part of the flood plain associated with the Assiniboine River and other rivers and creeks in the region. The topography is level to undulating. Runoff is slow to moderately slow, and permeability is moderate, but restricted during periods of high water in channels. These soils have been subject to inundation during years of above average water flows.

The soil is characterized by dark gray to grayish brown Ap or Ah horizons 10 to 15 cm thick, and a pale brown to light yellowish brown Ckgj horizon. The underlying strata may vary in color from light to dark and may have thin former surface and organic strata. Yellowish brown mottles of iron are common throughout the soil.

Miniota Series (MXI)

The Miniota series consists of moderately well to well drained Orthic Black soils developed on a thin mantle (<1 m) of moderately to strongly calcareous very fine sand to fine sandy loam textured sediments over moderately to strongly calcareous, medium sand to gravelly textured deposits. The topography varies from gently sloping to irregular, moderately rolling. They occur in close association with the imperfectly drained Wytonville and Kilmury soils and the poorly drained Bornett series. Runoff is moderate to moderately rapid, and permeability is rapid in the sandy strata and very rapid in the lower coarser strata.

The soil is characterized by a very dark gray to very dark grayish brown Ah horizon, 12 to 20 cm thick, a dark brown to brown Bm horizon, 10 to 18 cm thick, and a pale brown BCk horizon. The depth of solum varies with the depth of the sandy strata; the lime accumulation horizon usually occurs at the transition from sandy to coarser sediments. Miniota soils are less permeable and less droughty than the very similar coarser textured Wheatland and Dorset soils. The similar finer textured Croyon soils are less droughty.

Mowbray Series (MOW)

The Mowbray series consists of a well drained, Cumulic Regosol soil developed on deep, moderately to strongly calcareous, loamy (L, SiL, CL, SiCL) recent alluvial sediments. These deposits are stratified and contain dark colored bands of former Ah horizons in the profile. The soils are located in upper terrace and flood plain areas that have been inundated during years of high flood waters. They occur in association with the Levine and Basker soils.

Topography is very gently to moderately sloping, runoff is moderate and permeability is moderate.

The soil is characterized by a dark gray to gray surface horizon (Ah or Ap) 8 to 20 cm thick and a lighter colored (C) substratum with dark bands consisting of former organic layers or buried Ah horizons. These soils may exhibit weak profile development.

Oberon Series (OBR)

The Oberon series consists of imperfectly drained Gleyed Black soils developed on a thin mantle (<1 m) of strongly calcareous clay loam to sandy clay loam sediments grading to moderately calcareous sandy (FS,LFS,LS) deposits. They occur on level to gently sloping topography. Runoff is moderate to moderately slow; permeability is moderate in the upper loamy strata and moderately rapid in the sandy subsoil when not restricted by a high water table in early spring or summer.

The soil is characterized by a very dark gray Ah horizon, 18 to 25 cm thick, a subangular blocky brown to olive brown Bmgj horizon, 12 to 22 cm thick with yellowish brown mottles in the lower part of the horizon; a BCkg horizon, 8 to 16 cm thick. A lime accumulation is usually present within the loamy strata. The sandy substrata is light yellowish brown with yellowish brown to strong brown mottles of iron.

Prodan Series (PDA)

The Prodan series is a Gleyed Rego Black, carbonated soil developed on imperfectly drained, strongly to very strongly calcareous, fine loamy (CL, SiCL), lacustrine sediments. These soils occur in the Upper Assiniboine Delta and Brandon Lakes Plain on gently sloping topography in association with Ramada, Charman, Carroll and Tadpole soils. Surface runoff is moderately slow, and permeability is moderate to moderately slow. A seasonal water table frequently occurs within 70 cm of the surface.

The Prodan soil profile has a very dark gray Ah horizon, 18 to 25 cm thick; a dark gray to gray ACk horizon, 8 to 15 cm thick, and a Cca horizon. The Ckgj horizon is light brownish gray with yellowish brown mottles. This soil differs from the similar Charman series in not having a prominent Bmgj horizon. Prodan soils are finer textured and less permeable than the similar loamy textured Taggart and Torcan soils. The very similar Capell soils have coarse, sandy and gravelly textured subsoils that are very rapidly permeable.

Ramada Series (RAM)

The Ramada series is an Orthic Black soil developed on well to moderately well drained, strongly to very strongly calcareous, fine loamy (CL, SiCL), lacustrine sediments. These soils occur in the Upper Assiniboine Delta, and Brandon Lakes Plain on very gently sloping topography or on mid and upper slope positions of undulating topography associated with Barren, Carroll, Charman, Prodan and Tadpole soils. Surface runoff is moderately rapid, and permeability is moderate to moderately slow.

The Ramada soil profile has a very dark gray Ah horizon, 10 to 20 cm thick; a dark grayish brown to brown Bm horizon, 8 to 12 cm thick, and a BCk horizon, 6 to 10 cm thick. A Cca horizon is usually present. The Ck horizon is pale brown to light yellowish brown. This soil differs slightly from the Carroll soil in having a prominent Bm horizon. Ramada soils are finer textured and less permeable than the similar coarser textured, loamy Fairland soils, as well as, the Croyon and Zarnet soils which have coarse sandy and gravelly textured subsurface layers and very rapid permeability.

Sewell Series (SEE)

The Sewell series is a Rego Humic Gleysol, carbonated soil developed on poorly drained, weakly to moderately calcareous, sandy (FS, LFS, LS), lacustrine and fluvial sediments. These soils occur in the Upper Assiniboine Delta and Brandon Lakes Plain on level to depressional topography in association with Stockton, Lavenham and Hummerston soils. Surface runoff is negligible. Permeability is usually moderately rapid, but is restricted when the water table is within 1 meter of the surface.

The Sewell soil profile has a moderately decomposed organic layer, 2 to 5 cm thick; a very dark gray Ah horizon, 10 to 18 cm thick; a dark gray to gray ACk horizon with yellowish brown mottles; usually a Ccag horizon, 8 to 12 cm thick, and an olive to pale olive Ckg horizon with yellowish brown iron mottles and fine black manganese mottles. This soil differs from the very similar Mockry series, which is found on more uniformly fine sandy eolian deposits in being somewhat more stratified in its subsurface layers. Sewell soils are coarser textured and more permeable than the finer textured coarse loamy Poolex soils and the loamy textured Vordas and Tadpole soils. The poorly drained Carvey soils have finer textured surface layers and coarser textured subsurface layers than Sewell soils.

Shilox Series (SHX)

The Shilox series is an Orthic Regosol soil developed on moderately well to excessively drained, weakly to noncalcareous, sandy (FS, LS, S), dominantly eolian deposits. These soils occur in the central part of the Upper Assiniboine Delta and Brandon Lakes Plain in association with Onahan and Mockry soils on gently sloping to very gently sloping topography. These eolian soils have been stabilized by short prairie grasses, or they have been cultivated and seeded to grasses. Stunted aspen, juniper and some stunted bur oak occur on undisturbed sites. Surface runoff is very slow, and permeability is rapid to very rapid. Soil erosion has occurred in areas that have been formerly cultivated or overgrazed.

The Shilox soil profile has a partially decomposed LH horizon, 1 to 2 cm thick; a grayish brown to pale brown Ah horizon 6 to 10 cm thick, and a light yellowish brown to pale brown C horizon. Occasionally, a buried Ah horizon, 2 to 4 cm thick, is found within a meter depth. This soils differs from the similar sandy Arizona soils in being more uniformly fine sand in texture and less stratified in its subsurface textures because of eolian deposition. Shilox is differentiated from Skelding soils only on the basis that it occurs in a slightly cooler climatic subregion of the map project area.

Stockton Series (SCK)

The Stockton series is an Orthic Black soil developed on moderately well to well drained, weakly to moderately calcareous, sandy (FS, LFS, LS), lacustrine sediments. These soils occur in the Upper Assiniboine Delta, the Brandon Lakes Plain and a few areas within the Lower Assiniboine Delta on very gently sloping to irregular undulating topography in association with Cactus, Lavenham, Hummerston and Sewell soils. Surface runoff is moderate, and permeability is rapid. Wind erosion is common if the soil is not protected with adequate surface or trash cover.

The Stockton soil profile has a very dark gray to very dark grayish brown Ah, 18 to 25 cm thick; a brown to grayish brown Bm horizon, 12 to 22 cm thick; a pale brown to light yellowish brown BC horizon, 8 to 12 cm thick, and a very pale brown Ck horizon with a few yellowish brown mottles below 0.7 m depth. A Cca horizon is also frequently present. This soil differs from the very similar Cactus series in having a prominent Bm horizon. The sandy Stockton soils are coarser textured and significantly more rapidly permeable than the increasingly more finer textured Prosser, Fairland and Ramada soil series. The similar Croyon series is finer textured and less permeable in its surface layers and coarser textured in its subsurface layers than the Stockton soils.

Tadpole Series (TDP)

The Tadpole series is a Rego Humic Gleysol, carbonated developed on poorly drained, strongly to very strongly calcareous, fine loamy (CL, SiCL), lacustrine sediments. These soils occur in the Upper Assiniboine Delta and Brandon Lakes Plain in level to depressional positions of gently sloping to undulating topography in association with Carroll, Firdale, Charman and Danlin soils. Surface runoff is very slow and permeability is restricted. Free water occurs at or near the surface for a considerable part of the year. In areas where seepage water contains appreciable soluble salt, a sufficient salt accumulation can occur to inhibit or retard the growth of normal hydrophytic vegetation.

The Tadpole soil profile has a moderately decomposed organic layer, 2 to 6 cm thick; a very dark gray Ah horizon, 10 to 18 cm thick; a dark gray ACk horizon, 4 to 6 cm thick; a Ccag horizon, 10 to 15 cm thick, and an olive to olive gray Ckg horizon with distinct yellowish brown mottles. In areas affected by salts, white pseudomycelia are common in the surface horizons. Tadpole soils are finer textured and less permeable than the very similar and increasingly more coarse textured Vordas, Poolex and sandy Mockry and Sewell soils. The similar Carvey soils have coarser textured sandy to gravelly subsurface layers that are much more rapidly permeable than the Tadpole soils.

Wellwood Series (WWD)

The Wellwood series consists of well to moderately well drained Orthic Black soils developed on a thin mantle (25 to 75 cm) of strongly calcareous fine loamy (CL-SiCL) sediments grading to moderately calcareous sandy (FS, LFS, LS) deposits. Topography is very gently to gently sloping; runoff is moderate to moderately slow; permeability is moderate in the upper loamy strata and rapid in the sandy strata.

The soil is characterized by a deep black to very dark gray Ah horizon, 18 to 30 cm thick; a dark brown to brown, prismatic to subangular blocky Bm horizon, 16 to 24 cm thick, and a yellowish brown to pale brown BC horizon, 8 to 14 cm thick. A weak lime accumulation may be present.

Wheatland Series (WHL)

The Wheatland series consists of well to moderately well drained Orthic Black soils developed on a thin mantle (<1 m) of moderately to strongly calcareous sandy sediments (FS, LFS, LS) overlying moderately to strongly calcareous medium sand to gravelly textured deposits. Topography is very gently to gently sloping; runoff is moderately slow; permeability is rapid in the upper sandy strata and very rapid in the underlying coarser strata. These soils, if cultivated, are very susceptible to wind erosion.

The soil is characterized by a very dark gray to very dark grayish brown Ah horizon, 18 to 25 cm thick, a brown to yellowish brown Bm horizon, 12 to 24 cm thick, and a light yellowish brown BCk horizon. The solum extends to the contact of the coarser textured strata. A lime accumulation usually occurs at the top of the coarser strata. Wheatland soils are less droughty than the very similar, coarser textured Dorset series but more droughty and more permeable than the very similar, finer textured Miniota and Croyon soils.

PART 4

USE AND MANAGEMENT INTERPRETATIONS OF SOILS

4.1 INTRODUCTION

This section provides predictions of performance or soil suitability ratings for various uses of soils based on field observations of soil and landscape characteristics, laboratory data and on observations of soil behavior under specified conditions of land use and management. Suitability ratings or interpretations are intended only to serve as guides for planners and managers. Caution, with an understanding of the limitations of the soil map must be exercised when applying suitability ratings to soil map units. The value of any rating or interpretation depends upon the nature and composition of individual map unit delineation which in turn depends on the scale of mapping and intensity of ground truthing employed in the survey.

In this section, interpretive soil information is provided for the following land use evaluations:

1. Agriculture
   a) dryland farming capability
   b) irrigation suitability
2. Engineering Uses
3. Recreation Uses

4.2 SOIL CAPABILITY FOR AGRICULTURE

Dryland Agriculture

Soil capability classification for dryland agriculture is based on an evaluation of both internal and external soil characteristics that influence soil suitability and limitations for agricultural use. In this classification, mineral soils are grouped into capability classes, subclasses and units based on their limitations for dryland farming, risk of damage when the soils are used and the way they respond to management[2]. There are seven capability classes, each of which groups soils together that have the same relative degree of limitation or hazard for agricultural use. The limitation becomes progressively greater from Class 1 to Class 7. The class indicates the general suitability of the soils for agriculture. The first three classes are considered capable of sustained production of common field crops, the fourth is marginal for sustained arable culture, the fifth is suitable only for improved permanent pasture, the sixth is capable of use only for native pasture while the seventh class is for soils and land types considered incapable of use for arable agriculture or permanent pasture.

[2] Anon. 1965. Land capability classification for agriculture Report No. 2, Canada Land Inventory, Canada Dept. Regional Economic Expansion, Ottawa. 16 pp.

Organic soils within the map area are rated for "potential" agricultural capability after the method of Leeson[3]. Capability ratings of organic soils for agriculture must recognize that most organic soils have little or no value for agriculture in their native state and their potential is only achieved through reclamation or development implemented with varying degrees of difficulty. Capability class definitions for organic soils are the same as for mineral soils. They are however, identified on maps and tables with the prefix "O".

Soil Capability subclasses are divisions within classes which group soils with similar kinds of limitations and hazards for agricultural use. The various kinds of limitations recognized at the subclass level are defined in Table 4.

Soil capability units are divisions within the subclass category that groups soils together that will respond similarly to a given management input.

A summary of the soils in the study area showing their major characteristics and their interpretive classification for dryland agriculture is presented in Table 5.

[3] Leeson, Bruce et al. 1969. An organic soil capability classification for agriculture and a study of the organic soils of Simcoe County, Soil Sci. Dept., Ontario Agricultural College, Guelph, Ontario.

Definitions of the Agricultural Capability Classes

Class 1

Soils in this class have no important limitations for crop use. The soils have level or gently sloping topography; they are deep, well to imperfectly drained and have moderate water holding capacity. The soils are naturally well supplied with plant nutrients, easily maintained in good tilth and fertility; soils are moderately high to high in productivity for a wide range of cereal and special crops.

Class 2

Soils in this class have moderate limitations that reduce the choice of crops or require moderate conservation practices. The soils have good water holding capacity and are either naturally well supplied with plant nutrients or are highly responsive to inputs of fertilizer. They are moderate to high in productivity for a fairly wide range of crops. The limitations are not severe and good soil management and cropping practices can be applied without serious difficulty.

Class 3

Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. The limitations in Class 3 are more severe than those in Class 2 and conservation practices are more difficult to apply and maintain. The limitations affect the timing and ease of tillage, planting and harvesting, the choice of crops and maintenance of conservation practices. The limitations include one or more of the following: moderate climatic limitation, erosion, structure or permeability, low fertility, topography, overflow, wetness, low water holding capacity or slowness in release of water to plants, stoniness and depth of soil to consolidated bedrock. Under good management, these soils are fair to moderately high in productivity for a fairly wide range of field crops.

Class 4

Soils in this class have severe limitations that restrict the choice of crops or require special conservation practices or both. These soils have such limitations that they are only suited for a few crops, or the yield for a range of crops may be low, or the risk of crop failure is high. The limitations may seriously affect such farm practices as the timing and ease of tillage, planting and harvesting, and the application and maintenance of conservation practices. These soils are low to medium in productivity for a narrow range of crops but may have higher productivity for a specially adapted crop. The limitations include the adverse effects of one or more of the following: climate, accumulative undesirable soil characteristics, low fertility, deficiencies in the storage capacity or release of soil moisture to plants, structure or permeability, salinity, erosion, topography, overflow, wetness, stoniness, and depth of soil to consolidated bedrock.

Class 5

Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible. These soils have such serious soil, climatic or other limitations that they are not capable of use for sustained production of annual field crops. However, they may be improved by the use of farm machinery for the production of native or tame species of perennial forage plants. Feasible improvement practices include clearing of bush, cultivation, seeding, fertilizing and water control.

Some soils in Class 5 can be used for cultivated field crops provided unusually intensive management is used. Some of these soils are also adapted to special crops requiring soil conditions unlike those needed by the common crops.

Class 6

Soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible. Class 6 soils have some natural sustained grazing capacity for farm animals, but have such serious soil, climatic or other limitations as to make impractical the application of improvement practices that can be carried out on Class 5 soils. Soils may be placed in this class because their physical nature prevents the use of farm machinery, or because the soils are not responsive to improvement practices, or because stock watering facilities are inadequate.

Class 7

Soils in this class have no capability for arable culture or permanent pasture because of extremely severe limitations. Bodies of water too small to delineate on the map are included in this class. These soils may or may not have a high capability for forestry, wildlife and recreation.

TABLE 4

Agricultural Capability Subclass Limitations

C - Adverse climate: This subclass denotes a significant adverse climate for crop production as compared to the "median" climate which is defined as one with sufficiently high growing season temperatures to bring field crops to maturity, and with sufficient precipitation to permit crops to be grown each year on the same land without a serious risk of partial or total crop failures.

D - Undesirable soil structure and/or low permeability: This subclass is used for soils difficult to till, or which absorb water very slowly or in which the depth of rooting zone is restricted by conditions other than a high water table or consolidated bedrock.

E - Erosion: Subclass E includes soils where damage from erosion is a limitation to agricultural use. Damage is assessed on the loss of productivity and on the difficulties in farming land with gullies.

F - Low fertility: This subclass is made up of soils having low fertility that either is correctable with careful management in the use of fertilizers and soil amendments or is difficult to correct in a feasible way. The limitation may be due to lack of available plant nutrients, high acidity or alkalinity, low exchange capacity, high levels of carbonates or presence of toxic compounds.

I - Inundation by streams or lakes: This subclass includes soils subjected to inundation causing crop damage or restricting agricultural use.

L - Coarse wood fragments: In the rating of organic soils, woody inclusions in the form of trunks, stumps and branches (>10 cm diameter) in sufficient quantity to significantly hinder tillage, planting and harvesting operations.

M - Moisture limitation: This subclass consists of soils where crops are adversely affected by droughtiness owing to inherent soil characteristics. They are usually soils with low water-holding capacity.

N - Salinity: Designates soils which are adversely affected by the presence of soluble salts.

P - Stoniness: This subclass is made up of soils sufficiently stony to significantly hinder tillage, planting, and harvesting operations. Stony soils are usually less productive than comparable non-stony soils.

R - Consolidated bedrock: This subclass includes soils where the presence of bedrock near the surface restricts their agricultural use. Consolidated bedrock at depths greater than 1 meter from the surface is not considered as a limitation, except on irrigated lands where a greater depth of soil is desirable.

T - Topography: This subclass is made up of soils where topography is a limitation. Both the percent of slope and the pattern or frequency of slopes in different directions are important factors in increasing the cost of farming over that of smooth land, in decreasing the uniformity of growth and maturity of crops, and in increasing the hazard of water erosion.

W - Excess water: Subclass W is made up of soils where excess water other than that brought about by inundation is a limitation to their use for agriculture. Excess water may result from inadequate soil drainage, a high water table, seepage or runoff from surrounding areas.

X - Cumulative minor adverse characteristics: This subclass is made up of soils having a moderate limitation caused by the cumulative effect of two or more adverse characteristics which singly are not serious enough to affect the class rating.

Irrigation Suitability

Irrigation suitability of soils is determined by evaluating the nature of both internal and external soil characteristics[4]. The classification of soils for irrigation suitability consists of three categories: class, subclass and unit.

The suitability class groups soils having the same relative suitability or degree of limitation or hazard for irrigation use. Four classes are utilized grading from Class 1, which is very good to Class 4, which is poor. The four classes are:

Class 1 - Very good: These are soils of fine sandy loam to clay loam texture which are well suited for irrigation use. The soils have good water retention capacity, good permeability, low salt content, good drainage and low general gradient of land surface.

Class 2 - Good: These are soils of loamy fine sand to light clay texture which are moderately well suited for irrigation use. Slight limitation to use results from soil factors such as water holding capacity, permeability, depth of material, salt content, topographic factors such as slope and pattern or drainage restrictions arising from surface drainage and depth to water table.

Class 3 - Fair: These are coarse or fine textured soils which are fair to marginally suitable because of some unfavorable characteristics that limit production and cause management problems under irrigation use. Soil, topographic or drainage factors are more restrictive than in Class 2.

Class 4 - Poor: These are soils that are considered poor to unsuitable for irrigation use because of severe drainage problems, impermeable geologic material, salinity, very low water holding capacity, very rapid permeability, topography or a combination of these problems.

The suitability subclass identifies soils with similar kinds of limitations and hazards related to both internal and external soil characteristics. The internal characteristics include both permanent and non-permanent properties; the permanent properties are those that will not change over time whereas the non-permanent properties may be altered with time by specific management. The properties which affect irrigation suitability of soil are listed as follows:

1. Internal Characteristics

   a) Permanent - Texture, uniformity and depth of geologic deposit, hydraulic conductivity and water storage capacity

   b) Non-permanent - Structure, drainage, fertility, reaction, salinity, exchangeable sodium

2. External Characteristics

[4] PFRA. 1964. Handbook for the classification of irrigation land in the prairie provinces. Prepared by Committee of the Canada Dept. of Agriculture. PFRA, Regina, Sask. 92 pp.

a) Topography, erosion, stoniness, vegetative cover

The classification criteria for irrigation suitability are summarized in Table 11, Appendix E. The soils of the South Assiniboine River Study area are evaluated for irrigation suitability in Table 5.

TABLE 5. AGRICULTURE CAPABILITY CLASSES FOR SOILS

Map Symbol and Phase	Soil Name	Agricultural Capability Class	Irrigation Suitability [11]
AIZ	Arizona	4M	4S
AIZ /xcxx	Arizona	4M	4S
AIZ /xdxx	Arizona	4M	4S
BKR	Basker	5W	4D
BKR /xcxx	Basker	5W	4D
BKR /xdxx	Basker	5W	4D
CAV	Carvey	4W	4D
CKD	Crookdale	2W	2D
CYN	Croyon	3M	2S
CYN /xcxx	Croyon	3M	2ST
CYN /xdlx	Croyon	3MT	3T
CXT	Capell	2W	3SD
CXV	Charman	2W	2D
DOT	Dorset	5M	4S
DOT /xcxx	Dorset	5M	4S
DXM	Druxman	2W	3SD
ERX	Eroded Slope Compl	6T	4T
GBO	Glenboro	1	1
GBO /xcxx	Glenboro	2T	2T
GRO	Grover	2W	2D
HMO	Hummerston	3MW	3SD
HMO /xcxx	Hummerston	3MW	3SD
HRG	Harding	2W	4S
JIK	Janick	1	3S
LEI	Levine	2I	3D
LEI /xcxx	Levine	2T	3D
LEI /xdxx	Levine	3T	3DT
LVH	Lavenham	3MW	3SD
LVH /xcxx	Lavenham	3MW	3SD
LVH /xdxx	Lavenham	3MW	3ST
MOW	Mowbray	1	1
MOW /xcxx	Mowbray	2T	2T
MOW /xdxx	Mowbray	3T	3T
MXI	Miniota	4M	2S
OBR	Oberon	2W	2D
PDA	Prodan	2W	2D
RAM	Ramada	1	1
RAM /xcxx	Ramada	2T	2T
RAM /xdxx	Ramada	3T	3T
SCK	Stockton	3M	3S

TABLE 5. AGRICULTURE CAPABILITY CLASSES FOR SOILS

Map Symbol and Phase	Soil Name	Agricultural Capability Class	Irrigation Suitability [11]
SCK /xcxx	Stockton	3M	3S
SCK /lcxx	Stockton	3M	3S
SCK /xdxx	Stockton	3MT	3ST
SCK /ldxx	Stockton	3MT	3ST
SCK /xfxx	Stockton	5T	4T
SEE	Sewell	5W	4D
SEEp	Sewell	6W	4D
SHX	Shilox	5M	4S
SHX /xcxx	Shilox	5M	4S
SHX /xdxx	Shilox	5M	4S
SHX /xexx	Shilox	5M	4ST
SHX /xfxx	Shilox	5MT	4ST
SHX /xgxx	Shilox	6T	4ST
TDP	Tadpole	4W	4D
WHL	Wheatland	4M	4S
WHL /xcxx	Wheatland	4M	4S
WHL /lcxx	Wheatland	4M	4S
WHL /ldxx	Wheatland	4M	4S
WWD	Wellwood	1	1
WWD /xcxx	Wellwood	2T	2T
WWD /xdxx	Wellwood	3T	3T

4.3 SOIL SUITABILITY FOR SELECTED ENGINEERING USES

This section provides information which can be used by engineers and land use planners concerned with engineering and related geotechnical aspects of soil. It is intended to supplement the information on the soil map with additional data on engineering properties of soils.

The criteria used to evaluate soil suitability for selected engineering and related recreational uses are adopted from guides found in Coen et al[5]. and from guidelines developed by the Soil Conservation Service, United States Department of Agriculture[6] and the Canada Soil Survey Committee[7].

Definition of Soil Suitability Classes

Evaluation of soil suitability for engineering and recreation uses is based on both internal and external soil characteristics. Four soil suitability classes are used to evaluate both mineral and organic soils and hence, mapping units for selected uses. These ratings express relative degrees of suitability or limitation for potential uses of natural or essentially undisturbed soils. The long term effects of the potential use on the behavior of the soil are considered in the rating.

The four suitability class ratings are defined as follows:

Good - Soils in their present state have few or minor limitations that would affect the proposed use. The limitations would easily be overcome with minimal cost.

Fair - Soils in their present state have one or more moderate limitations that would affect the proposed use. These moderate limitations would be overcome with special construction, design, planning or maintenance.

Poor - Soils in their present state have one or more severe limitations that would severely affect the proposed use. To overcome these severe limitations would require the removal of the limitation or difficult and costly alteration of the soil or of special design or intensive maintenance.

Very Poor - Soils have one or more features so unfavorable for the proposed use that the limitation is very difficult and expensive to overcome or the soil would require such extreme alteration that the proposed use is economically impractical.

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[5] Coen et al. 1977. Soil Survey of Yoho National Park, Canada. Alberta Soil Survey Report No. 37. 208 pp. Alberta Institute of Pedology, University of Alberta, Edmonton, Alberta.

[6] USDA. 1971. Guide for Interpreting Engineering Uses of Soils. Soil Conservation Service, USDA. SCS-45. 87 pp.

[7] CSSC. 1973. Proceedings of the Ninth Meeting of the Canada Soil Survey Committee, University of Saskatchewan, Saskatoon. 357 pp.

Soil Suitability Subclasses

The basic soil properties that singly or in combination with others commonly affect soil suitability for selected engineering properties and recreation uses are provided in Table 6. These subclass designations serve to identify the kind of limitation or hazard for a particular use.

Guides for Assessing Soil Suitability

Guides for assessing soil suitability for ten engineering related uses are given in Appendix E, Tables 12 to 21. These tables provide as specifically as possible, definitions of the soil properties which result in the specific suitability or degree of limitation. In assessing soil suitability for various engineering uses, the degree of suitability is determined by the most restrictive or severe rating assigned to any one of the listed soil properties. For example, if the suitability is "Good" for all but one soil property and it is estimated to be "Very Poor", then the overall rating of the soil for that selected use is "Very Poor". Suitability of individual soil properties, if estimated to be "Fair" or "Poor", can be accumulative in their effect for a particular use. Judgement is required to determine whether the severity of the combined effects of several soil properties on suitability for a particular use will result in downgrading an evaluation. This is left to the discretion of the interpreter. It is incorrect to assume that each of the major soil properties influencing a particular use has an equal effect. Class limits established for rating the suitability of individual soil properties take this into account. For a selected use, therefore, only those soil properties which most severely limit that use are specified.

Engineering description of the soils and their estimated properties significant to engineering are provided in Table 7. These data, in addition to information contained in other sections of the report have been used to rate the soils according to their suitability for ten selected engineering uses in Table 8. When using these interpretations, consideration must be given to the following assumptions:

1. Interpretations are based on predictions of soil behavior under defined conditions of use and management as specified in the preamble to each of Tables 12 through 25 (Appendix E).

2. Soil ratings do not include site factors such as nearness to towns and highways, water supply, aesthetic values, etc.

3. Soil ratings are based on natural, undisturbed soil.

4. Soil suitability ratings are usually given for the entire soil, but for some uses, they may be based on the limitations of an individual soil horizon or other earthy layer, because of its overriding importance. Ratings rarely apply to soil depths greater than 1 to 2 meters, but in some kinds of soils, reasonable estimates can be given for soil material at greater depths. It should be noted here that the term "soil" has been used throughout the report in the pedologic sense and differs in concept from that commonly used by engineers.

5. Poor and very poor soil ratings do not imply that a site cannot be changed to remove, correct or modify the soil limitations. The use of soils rated as poor depends on the nature of the lim-

itations, whether or not the soil limitation can be altered successfully and economically, and on the scarcity of good sites.

6. Interpretations of map units do not eliminate the need for on-site evaluation by qualified professionals. Due to the variable nature of soils, and the scale of mapping, small, unmappable inclusions of soils with different properties may be present in an area where a development is planned. The need for or importance of on-site studies depends on the use to be made of the soil and the kinds of soil and soil problems involved.

4.4 SOIL SUITABILITY FOR SELECTED RECREATION USES

This section provides interpretations of the soil suitability for recreational development. All types of soil can be used for recreational activities of some kind.

Soils and their properties determine to a large degree, the type and location of recreational facilities. Wet soils are not suitable for campsites, roads, playgrounds or picnic areas. Soils that pond and dry out slowly after heavy rains present problems where intensive use is contemplated. It is difficult to maintain grass cover for playing fields and golf courses on droughty soils. The feasibility of many kinds of outdoor activities are determined by other basic soil properties such as depth to bedrock, stoniness, topography or land pattern, and the ability of the soil to support vegetation of different kinds as related to its natural fertility.

The suitability of the various soil series and phases for selected recreation uses is shown in Table 9 according to four classes, Good, Fair, Poor and Very poor defined previously in the section on Engineering Uses. Subclasses are employed to identify the kind of limitation or hazard for a particular use. An explanation of subclass symbols are provided in Table 6.

The guidelines for various recreation uses are presented in Appendix E, Tables 22 to 25 and 15.

TABLE 6

Codes utilized to identify limitations in evaluating soil suitability for selected Engineering and Recreational Uses(Tables 8 and 9)

a subgrade properties

b thickness of topsoil

c coarse fragments on surface

d depth to bedrock

e erosion or erodibility

f susceptibility to frost hazard

g contamination hazard of groundwater

h depth to seasonal water table

i flooding or inundation

j thickness of slowly permeable material

k permeability or hydraulic conductivity

l shrink-swell properties

m moisture limitations or deficit

n salinity or sulphate hazard

o organic matter

p stoniness

q depth to sand or gravel

r rockiness

s surface texture

t topographic slope class

u moist consistence

w wetness or soil drainage class

z permafrost

Table 7. Engineering Description of Soils and Their Estimated Properties Significant to Engineering.

Map Symbol	Soil Series Name	Depth (cm)	Textural Classification			% Passing Sieve			Permeability* (cm/hr)	Reaction (pH)	Sulfate Hazard**	Dispersion	Shrink-Swell Potential	Depth to Seasonal Water Table (m)
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
AIZ	Arizona	0-25	FS-LFS	SM	A-3, A-2-4	100	90-100	5-25	15-25	7.2-7.6	none	low	low	below 2 m
		25-100	FS	SM to SP	A-3	100	90-100	3-15	5-15	7.4-7.8	none	low	low	
BKR	Basker	0-20	SiL-SiCL	ML to CL	A-6, A-7	100	100	95-100	.5-2.0	7.6-8.0	low	low	mod.	at or
		20-60	strat. FSL-SiL CL	ML to CL	A-4 to A-7-6	100	100	65-100	-	7.8-8.2	low	low	mod.	near surface subject to flooding
		60-100	strat. SiL-SiCL	ML to CL	A-4 to A-7-6	100	100	75-100	-	7.8-8.2	low	low	mod.	
CAV	Carvey	0-25	SCL-L	SC or CL	A-4, A-6	100	80-95	40-75	-	7.8-8.2	low-mod.	low	mod.	seasonal at or
		25-50	SL-L	SM or CL	A-4, A-6	100	60-95	35-75	-	7.8-8.4	low-mod.	low	mod.	near surface
		50-100	CS-GrS	SP or GW	A-1	var.	<60	< 5	-	7.8-8.4	low-mod.	low	low	
CKD	Crookdale	25-75	SCL-CL	CL	A-6	100	100	60-80	1.5-5	7.4-7.8	low	low	mod.	seasonal
		75-100+	FS-LVFS	SM,SP,ML	A-2 to A-4	100	100	5-50	6-13	7.6-8.0	low	low	low	0.8 m
CYN	Croyon	0-25	SCL-L	CL	A-6	100	85-95	40-75	1.5-5.0	7.2-7.6	low	low	mod.	>2 m
		25-50	SL-L	CL or SM	A-4, A-6	90-100	60-95	35-75	1.5-5.0	7.8-8.2	low	low	low-mod.	
		50-100+	CS-GrS	SP	A-1	-	<20	< 5	>25	7.8-8.2	low	low	low	
CXT	Capell	0-20	SCL-L	CL	A-6, A-7-5	95-100	85-95	40-55	1.5-5.0	7.6-8.0	low	low	mod.	seasonal
		20-40	SCL-L	SC or CL	A-6, A-4	95-100	85-95	30-50	1.5-5.0	7.8-8.2	low	low	mod.	.8 m
		40-70	Gr-SL	SM	A-1, A-2	-	<50	15-30	25-50	7.8-8.2	low	low	low	
		70+	GrS	SP or GP	A-1	-	<45	< 5	>50	7.8-8.2	low	low	low	
CXV	Charman	0-20	CL	CL	A-7-6	100	100	90-100	1.5	7.4-7.8	low	low	mod.	
		20-80	SiCL	CL	A-7-6	100	100	90-100	1.5	7.8-8.2	low	low	mod.	1.2
		80-100	SiL-SiCL	CL	A-6, A-7-6	100	100	90-100	0.1-5.0	7.8-8.4	low	low	mod.	

Table 7. Cont'd

Map Symbol	Soil Series Name	Depth (cm)	Textural Classification			% Passing Sieve			Permeability* (cm/hr)	Reaction (pH)	Sulfate Hazard**	Dispersion	Shrink-Swell Potential	Depth to Seasonal Water Table (m)
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
DOT	Dorset	0-20	LFS-LS	Sp	A-2	100	90-100	10-35	15-25	7.0-7.4	low	low	low	> 2 m
		25-50	GrLS-GrS	GP-SP	A-1	35-60	30-50	< 5	> 25	7.4-7.8	low	low	low	
		50-100	S & Gr	GP-SP	A-1	35-60	20-30	< 5	> 25	7.8-8.2	low	low	low	
DXM	Druxman	0-20	L-GL	CL	A-4, A-6	100	90-100	70-90	1.5-5.0	7.0-7.4	low	low	mod.	> 2 m
		20-55	L-SiL	ML	A-4, A-6	100	90-100	70-90	1.5-5.0	7.6-8.0	low	low	mod.	
		55-80	LS	SM	A-2-4	var.	< 60	15-25	12.5-25	7.6-8.2	low	low	low	
		80-100+	S & Gr	Sp	A-1, A-2	var.	< 60	< 5	> 25	7.8-8.2	low	low	low	
GBO	Glenboro	0-40	L-VFSL	ML to CL	A-4, A-6	100	100	80-90	1.5-5	7.0-7.4	low	low	mod.	1.5 m
		40-90	strat. LFS-L	SM to ML	A-2 to A-4	100	90-100	30-90	0.5-2.5	7.4-7.8	low	low	mod.	
		90+	FS-LFS	SM to SP	A-2 to A-4	100	85-95	5-35	13-25	7.8-8.2	low	low	low	
GRO	Grover	0-40	L-SCL	ML to CL	A-4, A-6	100	100	80-90	1.5-5	7.4-7.8	low	low	mod.	seasonal
		40-90	strat.LFS-L	SM to ML	A-2 to A-4	100	90-100	30-90	1.5-5	7.8-8.4	low	low	mod.	0.7 m
		90+	FS-LFS	SM to SP	A-2 to A-4	100	85-95	5-40	1.5-5	7.8-8.4	low	low	low	
HMO	Hummerston	0-20	LFS-FSL	SM to Sp	A-2 to A-4	95-100	85-95	5-40	6-12	7.3-7.6	low	low	low	seasoanl
		20-100	FS-LFS	SM to Sp	A-2-4	95-100	80-95	5-35	6-12	7.6-8.0	low	low	low	0.6 m
HRG	Harding	0-20	C-SiC	OH	A-7-6	100	100	95-100	1.5-2.5	7.0-7.4	low	low	high	seasonal
		20-80	C-SiC	CH	A-7-6	100	100	95-100	.5-2.0	7.4-7.8	low	low	high	0.8 m
		80+	C-SiC	CH	A-7-6	100	100	95-100	< .12	7.8-8.2	mod.	mod.	high	
JIK	Janick	0-20	SiC-C	CH	A-7-6	100	95-100	85-95	1.5-2.5	7.2-7.6	low	low	high	1.5 m
		20-100	C-SiC	CH	A-7-6	100	95-100	85-95	.5-1.5	7.8-8.4	low	low	high	
LEI	Levine	0-10	VFSL-L	ML to CL	A-4 to A-7-6	100	100	65-100	1.5-5.0	7.4-7.8	low	low	mod.	seasonal
		20-100	strat. SiL-CL	ML to CL	A-4 to A-7-6	100	100	65-100	.5-1.5	7.8-8.4	low	low	mod.	0.8 m subject to occasional flooding

Table 7. Cont'd

Map Symbol	Soil Series Name	Depth (cm)	Textural Classification			% Passing Sieve			Permeability* (cm/hr)	Reaction (pH)	Sulfate Hazard**	Dispersion	Shrink-Swell Potential	Depth to Seasonal Water Table (m)
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
LVH	Lavenham	0-25	LFS	SM	A-2-4	100	90-100	10-25	15-25	7.0-7.4	low	low	low	seasonal
		25-50	FS-LFS	SM	A-3, A-2-4	100	90-100	5-25	15-25	7.6-7.8	low	low	low	0.8 m
		50-100	FS	SM	A-3, A-2-4	100	90-100	3-15	5-15	7.6-8.0	low	low	low	
MOW	Mowbray	0-25	SiL-SiCL	MH	A-6	100	100	90-100	.5-5.0	6.8-7.4	low	low	mod.	2 m
		25-100	VFSL-SiCL	ML-CL	A-4, A-6	100	100	80-100	.5-5.0	7.6-8.2	low	low	mod.	
MXI	Miniota	0-20	FSL	ML to SM	A-4 to A-6	100	100	45-80	6-12.0	6.5-7.0	low	low	low	1.5 m
		10-40	VFS-FSL	SM to ML	A-4 to A-7-5	100	100	-	2-6	6.5-7.0	low	low	low	
		40-100	S & Gr	GP to Sp	A-1	40-70	-	2-5	>25	7.4-7.8	low	low	low	
OBR	Oberon	0-25	SCL-CL	CL	A-6	100	100	60-80	1.5-5.0	7.2-7.6	low	low	mod.	seasonal
		25-75	SCL-CL	CL	A-6	100	100	60-80	1.5-5.0	7.6-8.0	low	low	mod.	0.8 m
		75-100	LFS-FS	SM, Sp ML	A-2 to A-4	100	100	5-50	6.-12.	7.8-8.4	low	low	low	
PDA	Prodan	0-30	CL	CL	A-7-6	100	100	90-100	1.5-5.0	7.6-8.0	low	low	mod.	seasonal
		30-60	CL-SiCL	CL	A-6, A-7-6	100	100	95-100	1.5-5.0	7.8-8.4	low	low	mod.	0.7 m
		60-100	VFSL-SiL	ML to CL	A-6	100	100	95-100	.5-2.0	7.8-8.4	mod.	low	mod.	
RAM	Ramada	0-20	CL	CL	A-7-6	100	100	90-100	0.5-2.0	7.3-7.8	low	low	mod.	
		20-75	SiCL	CL	A-6,A-7-6	100	100	85-95	1.5-5.0	7.4-7.8	low	low	mod.	> 2 m
		75-100	L-SiCL	CL	A-6, A-7-6	100	100	80-90	0.5-2.0	7.8-8.4	low	low	mod.	
SCK	Stockton	0-30	LFS	SM to Sp	A-2-4	100	85-95	5-35	> 25	6.8-7.2	low	low	low	> 2 m
		30-100	FS-LS	SM to Sp	A-3, A-2-4	100	85-95	3-15	13-25	7.4-7.8	low	low	low	
SEE	Sewell fine sandy loam	0-20	LFS-FSL	SM, Sp	A-2-4, A-4	100	100	5-50	<0.5	7.6-8.0	low	low	low	at or near surface
		20-100	FS-LVFS	SM,SP,ML	A-2-4, A-4	100	100	5-50	-	7.8-8.4	low	low	low	

Table 7. Cont'd

Map Symbol	Soil Series Name	Depth (cm)	Textural Classification			% Passing Sieve			Permeability* (cm/hr)	Reaction (pH)	Sulfate Hazard**	Dispersion	Shrink-Swell Potential	Depth to Seasonal Water Table (m)
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
SHX	Shilox	0-20	LFS-FS	SM to SP	A-2-4	100	80-100	10-35	15.0-25.0	6.6-7.2	low	low	low	> 2 m
		20-100	FS-LFS-S	SW to SP	A-3, A-2-4	100	60-90	7-35	15.0-25.0	7.6-8.0	low	low	low	
TDP	Tadpole	0-30	CL	CL	A-7-6	100	100	90-100	<0.2	7.6-8.0	low	low	mod.-high	at or near
		30-60	CL-SiCL	CL	A-6, A-7-6	100	100	95-100	-	7.8-8.4	low	low	mod.	surface
		60-100	strat. VFSL-SiL-SiCL	ML to CL	A-6	100	100	95-100	-	7.8-8.4	mod.	mod.	mod.	
WHL	Wheatland	0-20	SL	SM	A-2-4	100	50-75	10-35	12-25	7.0-7.4	low	low	low	2 m
		20-40	LFS-LS	SP,SM,SW	A-2-4	100	50-75	10-35	12-25	7.4-7.8	low	low	low	
		40-100	MS,CS,FGr	GP,Sp	A-1, A-2	50-100	20-60	2	>25	7.8-8.2	low	low	low	
WWD	Wellwood	0-40	SCL-CL	CL	A-6	100	100	60-80	1.5-5.0	7.0-7.4	low	low	mod.	
		40-85	SCL-CL	CL	A-6	100	100	60-80	1.5-5.0	7.8-8.4	low	low	mod.	> 2 m
		85-100	FS-LVFS	SM,SP,ML	A-2 to A-6	100	100	5-50	6-13	7.8-8.4	low	low	low	

*Permeability of horizons or layers is expressed cm/hr

very rapid	> 25	cm/hr	moderate	2.5-5.0	cm/hr
rapid	15-25	cm/hr	moderately slow	1.5-2.5	cm/hr
moderately rapid	5-15	cm/hr	slow	.125-1.5	cm/hr
			very slow	< .125	

**Sulfate Hazard - relative degree of sulfate attack based on criteria established by U.S. Bureau of Reclamation.

TABLE 8. SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase	Soil Name	Top Soil (12)	Sand & Gravel (13)	Road Fill (14)	Permanent Bldgs. With Basements (15)	Local Roads and Streets (16)	Sanitary Trench (17)	Landfill Area (18)	Cover Material (19)	Sewage Lagoons (20)	Septic Fields (21)
AIZ	Arizona	Vbs	Fa	G	G	G	Vs	Pk	Vs	Vak	Gg
AIZ /xcxx	Arizona	Vbs	Fa	G	G	G	Vs	Pk	Vs	Vak	Gg
AIZ /xdxx	Arizona	Vbs	Fa	G	G	G	Vs	Pk	Vs	Vak	Gg
BKR	Basker	Pi	Va	Pw	Vi	Vi	Vhi	Vhi	Pw	Vi	Vhi
BKR /xcxx	Basker	Pi	Va	Pw	Vi	Vi	Vhi	Vhi	Pw	Vi	Vhi
BKR /xdxx	Basker	Pi	Va	Pw	Vi	Vi	Vhi	Vhi	Pw	Vi	Vhi
CAV	Carvey	Fs	Fa	Pw	Pw	Pw	Vwg	Vhg	Pw	Vkg	Vhg
CKD	Crookdale	Fsb	Paq	Fw	Pw	Fwa	Vs	Pk	Fs	Pa	Fkh
CYN	Croyon	Fbs	G	G	G	G	Vsk	Pkg	Pq	Vka	Gg
CYN /xcxx	Croyon	Fbs	G	G	G	G	Vsk	Pkg	Pq	Vka	Gg
CYN /xdlx	Croyon	Fbt	G	G	G	G	Vsk	Pkg	Pq	Vka	Gg
CXT	Capell	Fbs	G	Fw	Pw	Faw	Vsk	Pk	Pq	Vka	Phg
CXV	Charman	Fsb	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fa	Phk
DOT	Dorset	Pbs	G	G	G	G	Vsk	Vkg	Vs	Vak	Gg
DOT /xcxx	Dorset	Pbs	G	G	G	G	Vsk	Vkg	Vs	Vak	Gg
DXM	Druxman	Fs	G	Fw	Pw	Fw	Vsg	Phg	Pq	Vag	Phg
ERX	Eroded Slope Compl	Vt	Va	Pt	Vt	Vt	Pt	Vt	Vt	Vt	Vt
GBO	Glenboro	G	Pa	Fal	G	G	Pk	G	G	Pka	Gg
GBO /xcxx	Glenboro	G	Pa	Fa	G	G	Pk	G	G	Pka	Gg
GRO	Grover	G	Pa	Faw	Pw	Fw	Vs	Fw	Fs	Pka	Fh
HMO	Hummerston	Ps	Pa	Fw	Pw	Fw	Vsk	Vk	Vs	Vk	Ph
HMO /xcxx	Hummerston	Ps	Pa	Fw	Pw	Fw	Vsk	Vk	Vs	Vk	Ph
HRG	Harding	Ps	Va	Pa	Paw	Pa	Ps	Fw	Ps	G	Pk
JIK	Janick	Ps	Va	Pa	Pa	Pa	Ps	G	Ps	G	Pk
LEI	Levine	Fis	Va	Faw	Piw	Pi	Pi	Pi	Fs	Vi	Pi
LEI /xcxx	Levine	Fis	Va	Faw	Piw	Pi	Pi	Pi	Fs	Vi	Pi
LEI /xdxx	Levine	Fst	Va	Faw	Piw	Pi	Pi	Pi	Fs	Vi	Pi
LVH	Lavenham	Ps	Pa	Fw	Pw	Fw	Vk	Vk	Vs	Vk	Ph
LVH /xcxx	Lavenham	Ps	Pa	Fw	Pw	Fw	Vsk	Vk	Vs	Vk	Ph
LVH /xdxx	Lavenham	Ps	Pa	Fw	Pw	Fw	Vsk	Vk	Vs	Vk	Ph

TABLE 8. SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase	Soil Name	Top Soil (12)	Sand & Gravel (13)	Road Fill (14)	Permanent Bldgs. With Basements (15)	Local Roads and Streets (16)	Sanitary Trench (17)	Landfill Area (18)	Cover Material (19)	Sewage Lagoons (20)	Septic Fields (21)
MOW	Mowbray	Fis	Va	Fa	Fa	Fia	Fis	Fi	Fs	Fa	Fk
MOW /xcxx	Mowbray	Fis	Va	Fa	Fa	Fia	Fis	Fi	Fs	Fat	Fk
MOW /xdxx	Mowbray	Fit	Va	Fa	Fa	Fia	Fis	Fi	Fs	Pt	Fk
MXI	Miniota	Fb	G	G	G	G	Vsk	Pka	Pq	Vka	Gg
OBR	Oberon	Fsb	Paq	Fw	Pw	Fwa	Vs	Pk	Fs	Pa	Fkh
PDA	Prodan	Fw	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fk	Ph
RAM	Ramada	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fk	Fk
RAM /xcxx	Ramada	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fkt	Fk
RAM /xdxx	Ramada	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Fk
SCK	Stockton	Ps	Fa	G	G	G	Vs	Pk	Vs	Vk	Gg
SCK /xcxx	Stockton	Ps	Fa	G	G	G	Vs	Pk	Vs	Vk	Gg
SCK /lcxx	Stockton	Ps	Fa	G	G	G	Vs	Pk	Vs	Vk	Gg
SCK /xdxx	Stockton	Ps	Fa	G	G	G	Vs	Pk	Vs	Vk	Gg
SCK /ldxx	Stockton	Psb	Fa	G	G	G	Vs	Pk	Vs	Vk	Gg
SCK /xfxx	Stockton	Vt	Fa	Ft	Pt	Pt	Vs	Pkt	Vs	Vk	Ptg
SEE	Sewell	Ps	Pa	Pw	Vw	Pw	Vw	Pw	Pw	Vhk	Vh
SEEp	Sewell	Ps	Ph	Vw	Vw	Pw	Vwh	Vw	Vsw	Vh	Vh
SHX	Shilox	Vb	Fa	G	G	G	Vks	Vk	Vs	Vk	Gg
SHX /xcxx	Shilox	Vb	Fa	G	G	G	Vks	Vk	Vs	Vk	Gg
SHX /xdxx	Shilox	Vb	Fa	G	G	G	Vks	Vk	Vs	Vk	Gg
SHX /xexx	Shilox	Vb	Fa	G	Ft	Ft	Vks	Vk	Vs	Vkt	Ftg
SHX /xfxx	Shilox	Vbt	Fa	Ft	Pt	Pt	Vks	Vk	Vs	Vkt	Ptg
SHX /xgxx	Shilox	Vt	Fa	Pt	Vt	Vt	Vks	Vkt	Vst	Vkt	Vtg
TDP	Tadpole	Fs	Va	Pw	Vw	Pw	Vw	Pw	Pw	Fa	Vh
WHL	Wheatland	Ps	G	G	G	G	Vsk	Vkg	Pq	Vka	Gg
WHL /xcxx	Wheatland	Ps	G	G	G	G	Vsk	Vkg	Pq	Vka	Gg
WHL /lcxx	Wheatland	Ps	G	G	G	G	Vsk	Vkg	Pq	Vka	Gg
WHL /ldxx	Wheatland	Ps	G	G	G	G	Vsk	Vkg	Pq	Vka	Gg
WWD	Wellwood	Fs	Pa	Fa	G	Fa	Vsk	Gg	Fs	Pka	Fkg
WWD /xcxx	Wellwood	Fs	Pa	Fa	G	Fa	Vsk	Gg	Fs	Pka	Fkg

TABLE 8. SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase	Soil Name	Top Soil (12)	Sand & Gravel (13)	Road Fill (14)	Permanent Bldgs. With Basements (15)	Local Roads and Streets (16)	Sanitary Trench (17)	Landfill Area (18)	Cover Material (19)	Sewage Lagoons (20)	Septic Fields (21)
WWD /xdxx	Wellwood	Fst	Pa	Fa	G	Fa	Vsk	Gg	Fs	Pat	Fkg

TABLE 9. SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

Map Symbol and Phase	Soil Name	Play Ground [22]	Picnic Area [23]	Camp Area [24]	Path And Trails [25]	Permanent Bldgs. Without Basements [15]
AIZ	Arizona	Ps	Fs	Fs	Ps	G
AIZ /xcxx	Arizona	Ps	Psm	Psm	Ps	G
AIZ /xdxx	Arizona	Pst	Psm	Psm	Ps	G
BKR	Basker	Piw	Pwi	Pwi	Pw	Vi
BKR /xcxx	Basker	Piw	Piw	Piw	Pw	Vi
BKR /xdxx	Basker	Pit	Piw	Piw	Pw	Vi
CAV	Carvey	Pw	Pw	Pw	Pw	Pw
CKD	Crookdale	Fsw	Fs	Fsw	Fsw	Fw
CYN	Croyon	Fs	Fs	Fs	Fs	G
CYN /xcxx	Croyon	Fst	Fs	Fs	Fs	G
CYN /xd1x	Croyon	Pt	Fs	Fs	Fs	G
CXT	Capell	Fsw	Fsw	Fs	Fsw	Faw
CXV	Charman	Fsw	Fsw	Fsw	Fsw	Fah
DOT	Dorset	Fsm	Fs	Fs	G	G
DOT /xcxx	Dorset	Fst	Fs	Fs	G	G
DXM	Druxman	Fsw	Fsw	Fsw	Fsw	Fwa
ERX	Eroded Slope Compl	Vt	Vt	Vt	Pt	Vt
GBO	Glenboro	G	G	G	G	G
GBO /xcxx	Glenboro	Fts	G	G	G	G
GRO	Grover	Fw	Fsw	Fsw	Fsw	Faw
HMO	Hummerston	Fsw	Fsw	Fsw	Fw	Faw
HMO /xcxx	Hummerston	Fsw	Fsw	Fsw	Fw	Fw
HRG	Harding	Ps	Pws	Pws	Ps	Pa
JIK	Janick	Fs	Fs	Fs	Fs	Pa
LEI	Levine	Fsi	Fsi	Fis	Fsw	Pi
LEI /xcxx	Levine	Fts	Fsi	Fis	Fsw	Pi
LEI /xdxx	Levine	Pt	Fsi	Fis	Fsw	Pi
LVH	Lavenham	Fws	Fws	Fws	Fw	Fw
LVH /xcxx	Lavenham	Fsw	Fsw	Fsw	Fw	Fw
LVH /xdxx	Lavenham	Pt	Fsw	Fsw	Fw	Fw
MOW	Mowbray	Fs	Fs	Fs	Fs	Fa
MOW /xcxx	Mowbray	Fst	Fs	Fs	Fs	Fa
MOW /xdxx	Mowbray	Pt	Fs	Fs	Fs	Fa
MXI	Miniota	Fsq	Fs	Fs	G	G
OBR	Oberon	Fsw	Fs	Fsw	Fsw	Fw
PDA	Prodan	Fsw	Fsw	Fsw	Fsw	Faw
RAM	Ramada	Fs	Fs	Fs	Fs	Fa
RAM /xcxx	Ramada	Fst	Fs	Fs	Fs	Fa
RAM /xdxx	Ramada	Pt	Fs	Fs	Fs	Fa
SCK	Stockton	Fsm	Fsm	Fs	G	G

TABLE 9. SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

Map Symbol and Phase	Soil Name	Play Ground [22]	Picnic Area [23]	Camp Area [24]	Path And Trails [25]	Permanent Bldgs. Without Basements [15]
SCK /xcxx	Stockton	Fmt	Fsm	Fs	G	G
SCK /lcxx	Stockton	Fmt	Fsm	Fs	G	G
SCK /xdxx	Stockton	Pt	Fsm	Fs	G	G
SCK /ldxx	Stockton	Pt	Fsm	Fs	G	G
SCK /xfxx	Stockton	Vt	Pt	Pt	Ft	Pt
SEE	Sewell	Pw	Pw	Pw	Pw	Pw
SEEp	Sewell	Vsw	Vsw	Vsw	Vs	Vah
SHX	Shilox	Vs	Vs	Vs	Vs	G
SHX /xcxx	Shilox	Vs	Vs	Vs	Vs	G
SHX /xdxx	Shilox	Vs	Vs	Vs	Vs	G
SHX /xexx	Shilox	Vst	Vs	Vs	Vs	Ft
SHX /xfxx	Shilox	Vst	Vs	Vs	Vs	Pt
SHX /xgxx	Shilox	Vts	Vts	Vts	Vs	Vt
TDP	Tadpole	Pw	Pw	Pw	Pw	Pw
WHL	Wheatland	Ps	Fs	Fs	G	G
WHL /xcxx	Wheatland	Ps	Fs	Fs	G	G
WHL /lcxx	Wheatland	Ps	Fs	Fs	G	G
WHL /ldxx	Wheatland	Pt	Fs	Fs	G	G
WWD	Wellwood	Fs	Fs	Fs	Fs	G
WWD /xcxx	Wellwood	Fst	Fs	Fs	Fs	G
WWD /xdxx	Wellwood	Pt	Fs	Fs	Fs	G

Appendix A

GLOSSARY

AASHO classification (soil engineering) - The official classification of soil materials and soil aggregate mixtures for highway construction used by the American Association of State Highway Officials.

Acid soil - A soil having a pH less than 7. See pH and Reaction, soil.

Alkaline soil - A soil having a pH greater than 7. See Reaction, soil.

Alluvium - A general term for all deposits of rivers and streams.

Arable soil - Soil suitable for plowing and cultivation.

Association - A sequence of soils of about the same age, derived from similar parent material, and occuring under similar climatic conditions but showing different characteristics due to variations in relief and in drainage.

1/3 Atmosphere Moisture - The moisture percentage on dry weight basis of a soil sample that has been air dried, screened, saturated and subjected to a soil moisture tension of 345 cm of water through a permeable membrane for a period of 48 hours. It approximates the soil moisture retention capacity.

Available nutrient - That portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants.

Available soil moisture - The portion of water in a soil that can be readily absorbed by plant roots: generally considered to be that water held in the soil up to approximately 15 atmospheres pressure.

Bearing capacity - Capacity of soil (in moist to wet conditions) to support loads such as buildings, people, vehicles, and animals.

Bedrock - The solid rock that underlies soil and regolith or that is exposed at the surface.

Boulders - Stones which are larger than 60 cm in diameter.

Bulk density - The weight of oven dry soil (105 degrees C) divided by its volume at field moisture conditions, expressed in grams per cubic centimeter.

Buried soil - Soil covered by an alluvial, loessial, or other deposit, usually to a depth greater than the thickness of the solum.

Calcareous soil - Soil containing sufficient calcium carbonate (often with magnesium carbonate) to effervesce visibly when treated with hydrochloric acid.

Calcium Carbonate Equivalent - Refers to the percent of carbonates in the soil expressed on the basis of calcium carbonate. Terms used to express the carbonate contents of soils are:

noncalcareous	<1%
weakly calcareous	1-5%
moderately calcareous	6-15%
strongly calcareous	16-25%
v. strongly calcareous	26-40%
extremely calcareous	>40%

Capillary fringe - A zone of essentially saturated soil just above the water table. The size distribution of the pores determines the extent and degree of the capillary fringe.

Carbon-nitrogen ratio (C/N ratio) - The ratio of the weight of organic carbon to the weight of total nitrogen in a soil or in an organic material.

Cation Exchange Capacity (CEC) - A measure of the total amount of exchangeable cations that can be held by a soil. Expressed in milliequivalents per 100g of soil.

Clay - As a soil separate, the mineral soil particles less than 0.002 mm in diameter: usually consisting largely of clay minerals. As a soil textural class, soil materials that contain 40 or more percent clay, less than 45 percent sand and less than 40 percent silt.

Cobbles - Rock fragments 8 to 25 cm in diameter.

Color - Soil colors are compared with a Munsell color chart. The Munsell system specifies the relative degrees of the three simple variables of color: hue, value and chroma. For example: 10YR 6/4 means a hue of 10YR, a value of 6, and a chroma of 4.

Complex (soil) - A mapping unit used in detailed and reconnaissance soil surveys where two or more soil series that are so intimately intermixed in an area that it is impractical to separate them at the scale of mapping used.

Concretions - Hard grains, pellets or nodules from concentration of compounds in the soil that cement soil grains together.

Conductivity, electrical - A physical quantity that measures the readiness with which a medium (irrigation water and soil extracts) transmits electricity. It expresses the concentration of salt in terms of the conductance (reciprocal of the electric resistance in ohms) in millisiemens per cm.

Consistence (soil) - The mutual attraction of the particles in a soil mass, or their resistence to separation or deformation. It is described in terms such as loose, soft, friable, firm, hard, sticky, plastic or cemented.

Consumptive use factor (CU) - The ratio of consumptive use of water by a crop to potential evapotranspiration. and transpiration. An actively growing crop that completely covers the soil over a large area and that has an ample supply of readily available soil water has a consumptive use factor of 1.0.

Consumptive use of water - The sum of the depths of water transpired by the plants and evaporated from the soil surface and from intercepted precipitation. It may be less or greater than potential evapotranspiration.

Contour - An imaginary line connecting points of equal elevation on the surface of the soil.

Cover - This term generally has one of the following meanings:

1. Vegetation or other material providing protection

2. In forestry, low growing shrubs and herbaceous plants under trees (i.e., ground cover vs. tree cover)

3. Any vegetation producing a protective mat on or just above the soil surface.

Creep (soil) - Slow mass movement of soil and soil material down rather steep slopes primarily under the influence of gravity, but aided by saturation with water and by alternate freezing and thawing.

Decile portion - A one-tenth portion. As used in the soil map symbol A7-B3 means that the A soils cover seven tenths and the B soils cover three tenths of the map unit.

Delta - A fluvial or glaciofluvial fan shaped deposit at the mouth of a river that empties into a lake or sea.

Deflocculate - To separate or to break up soil aggregates into individual particles by chemical or physical means or both.

Degradation (of soils) - The changing of a soil to a more highly leached and more highly weathered condition, usually accompanied by morphological changes such as the development of an eluviated light colored (Ae) horizon.

Dispersion - Is rated high, moderate or low depending on how readily the soil structure breaks down or slakes because of excess moisture. A rating of high indicates that soil aggregates slake readily; a rating of low indicates that aggregates are resistant to dispersion and remain clumped together.

Drainage (soil) - (1) The rapidity and extent of the removal of water from the soil by runoff and flow through the soil to underground spaces. (2) As a condition of the soil, it refers to the frequency and duration of periods when the soil is free of saturation.

Drainage in soil reports is described on the basis of actual moisture content in excess of field capacity and length of the saturation period within the plant root zone. The terms are as follows:

Very rapidly drained - Water is removed from the soil very rapidly in relation to supply. Excess water flows downward very rapidly if underlying material is pervious. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Soils have very low available water storage capacity (usually less than 2.5 cm) within the control section and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Rapidly drained - Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Soils have low available water storage capacity (2.5-4 cm) within the

control section, and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Well drained - Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Soils have intermediate available water storage capacity (4-5 cm) within the control section, and are generally intermediate in texture and depth. Water source is precipitation. On slopes subsurface flow may occur for short durations but additions are equaled by losses. These soils are usually free of mottles within 100 cm of the surface but may be mottled below this depth. Soil horizons are usually bright colored.

Moderately well drained - Water is removed from the soil somewhat slowly in relation to supply. Excess water is removed somewhat slowly due to low perviousness, shallow water table, lack of gradient, or some combination of these. Soils have intermediate to high water storage capacity (5-6cm) within the control section and are usually medium to fine in texture. Soils are commonly mottled in the 50 to 100 cm depth. Colors are dull brown in the subsoil with stains and mottles.

Imperfectly drained - Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is major supply. If subsurface water or groundwater, or both, is the main source, flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is the main source if available water storage capacity is high; contribution by subsurface flow or groundwater flow, or both, increases as available water storage capacity decreases. Soils have a wide range in available water supply, texture, and depth, and are gleyed phases of well drained subgroups. These soils generally have mottling below the surface layers and generally have duller colors with depth, generally brownish gray with mottles of yellow and gray.

Poorly drained - Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface flow or groundwater flow, or both, in addition to precipitation are main water sources; there may also be a perched water table, with precipitation exceeding evapotranspiration. Poorly drained soils have a wide range in available water storage capacity, texture, and depth, and are gleyed subgroups, Gleysols, and Organic soils.

Very poorly drained - Water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen. Excess water is present in the soil for the greater part of the time. Groundwater flow and subsurface flow are major water sources. Precipitation is less important except where there is a perched water table with precipitation exceeding evapotranspiration. These soils have a wide range in available water

storage capacity, texture, and depth, and are either Gleysolic or Organic.

Dryland farming - The practice of crop production in low rainfall areas without irrigation.

Eluvial horizon - A horizon from which material has been removed in solution or in water suspension.

Eolian - Soil material accumulated through wind action.

Erosion - The wearing away of the land surface by detachment and transport of soil and rock material through the action of moving water, wind or other geological processes. The ratings of erosion are:

Erosion 1 slightly eroded - soil with a sufficient amount of the A horizon removed that ordinary tillage will bring up and mix the B horizon or other lower lying horizons with surface soil in the plow layer.

Erosion 2 moderately eroded - soil with all of the A horizon and a part of the B or other lower lying horizons removed. The plow layer consists mainly of the original horizons below the A or below the original plow layer.

Erosion 3 severely eroded - soils have practically all of the original surface soil removed. The plow layer consists mainly of C horizon material, especially on knolls and steep upper slope positions.

Evapotranspiration - The combined loss of water from a given area, and during a specific period of time, by evaporation from the soil surface and transpiration from plants.

Field Moisture Equivalent - The minimum moisture content at which a drop of water placed on a smoothed surface of the soil will not be absorbed immediately by the soil, but will spread out over the surface and give it a shiny appearance.

Flood plain - The land bordering a stream, built up of sediments from overflow of the stream and subject to innundation when the stream is at flood stage.

Fluvial deposits - All sediments past and present, deposited by flowing water, including glaciofluvial deposits.

Frost heave - The raising of the surface caused by ice in the subsoil.

Friable - Soil aggregates that are soft and easily crushed between thumb and forefinger.

Glaciofluvial deposits - Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. These deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers and kame terraces.

Gleyed soil - An imperfectly or poorly drained soil in which the material has been modified by

reduction or alternating reduction and oxidation. These soils have lower chromas or more prominent mottling or both in some horizons than the associated well-drained soil.

Gleysolic - An order of soils developed under wet conditions and permanent or periodic reduction. These soils have low chromas or prominent mottling or both, in some horizons.

Gravel - Rock fragments 2 mm to 7.5 cm in diameter.

Ground Moraine - An unsorted mixture of rocks, boulders, sand, silt and clay deposited by glacial ice. The predominant material is till; most till is thought to have accumulated under the ice by lodgment, but some till has been let down from the upper surface of the ice by ablation. Resorting and modification may have taken place to some extent by wave-action of glacial melt waters. The topography is most commonly in the form of undulating plains with gently sloping hills and enclosed depressions.

Groundwater - Water beneath the soil surface, usually under conditions where the voids are completely filled with water (saturation).

Halophytic vegetation - vegetation that grows naturally in soils having a high content of various salts. It usually has fleshy leaves or thorns and resembles desert vegetation.

Horizon (soil) - A layer in the soil profile approximately parallel to the land surface with more or less well-defined characteristics that have been produced through the operation of soil forming processes.

Horizon boundary - The lower boundary of each horizon is described by indicating its distinctness and form. The distinctness depends on the abruptness of vertical change (thickness). The form refers to the variation of the boundary plane.

Distinctness -
abrupt - less than 2 cm
clear - 2 to 5 cm
gradual - 5 to 15 cm
diffuse - more than 15 cm

Form -
smooth - nearly plain
wavy - pockets are wider than deep
irregular - pockets are deeper than wide
broken - parts of the horizon are unconnected with other parts

Humic layer - A layer of highly decomposed organic soil material containing little fibre.

Hydraulic Conductivity - Refers to the effective flow velocity or discharge velocity in soil at unit hydraulic gradient. It is an approximation of the permeability of the soil and is expressed in cm per hour. The classes are described in general or specific terms as:

High	>15	Very rapid	>50
		Rapid	15-50
Medium	0.5-15	Mod. rapid	5.0-15
		Moderate	1.5-5.0
		Mod. slow	0.5-1.5
Low	<0.5	Slow	0.15-0.5
		Very slow	0.015-0.15
		Extremely slow	<.015

Hydrologic cycle - The conditions through which water naturally passes from the time of precipitation until it is returned to

the atmosphere by evaporation and is again ready to be precipitated.

Hydrophyte - Plants growing in water or dependent upon wet or saturated soil conditions for growth.

Illuvial horizon - A soil horizon in which material carried from an overlying layer has been precipitated from solution or deposited from suspension. The layer of accumulation.

Impeded drainage - A condition that hinders the movement of water by gravity through the soils.

Inclusion - Soil type found within a mapping unit that is not extensive enough to be mapped separately or as part of a complex.

Infiltration - The downward entry of water into the soil

Irrigation - The artificial application of water to the soil for the benefit of growing crops.

Irrigation requirement (IR) - Refers to the amount of water exclusive of effective precipitation that is required for crop production.

Lacustrine deposits - Material deposited by or settled out of lake waters and exposed by lowering of the water levels or elevation of the land. These sediments range in texture from sand to clay and are usually varved (layered annual deposits).

Landforms - See Description of Landforms

Landscape - All the natural features such as fields, hills, forest, water, etc., which distinquish one part of the earth's surface from another part.

Leaching - The removal from the soil of materials in solution.

Liquid limit (upper plastic limit) - The water content corresponding to an arbitrary limit between the liquid and plastic states of consistency of a soil. The water content at this boundary is defined as that at which a pat of soil cut by a groove of standard dimensions will flow together for a distance of 1.25 cm under the impact of 25 blows in a standard liquid limit apparatus.

Lineal shrinkage - This is the decrease in one dimension expressed as a percentage of the original dimension of the soil mass when the moisture content is reduced from a stipulated percentage (usually field moisture equivalent) to the shrinkage limit.

Mapping Unit - Any delineated area shown on a soil map that is identified by a symbol. A mapping unit may be a soil unit, a miscellaneous land type, or a soil complex.

Marsh - Periodically flooded or continually wet areas having the surface not deeply submerged. It is covered dominantly with sedges, cattails, rushes or other hydrophytic plants.

Mature soil - A soil having well-developed soil horizons produced by the natural processes of soil formation.

Mesophyte - Plants requiring intermediate moisture conditions and are not very resistant to drought.

Microrelief - Small-scale, local differences in relief including mounds, swales or hollows.

Milliequivalent (me) - One-thousandth of an equivalent. An equivalent is the weight in grams of an ion or compound that combines with or replaces one gram of hydrogen. The atomic or formula weight divided by valence.

Mottles - Irregularly marked spots or streaks, usually yellow or orange but sometimes blue. They are described in order of abundance (few, common, many), size (fine, medium, coarse) and contrast (faint, distinct, prominent). Mottles in soils indicate poor aeration and lack of good drainage.

Organic carbon - Carbon derived from plant and animal residues.

Organic matter - The fraction of the soil which consists of plant and animal residues at various stages of decomposition, cells and tissues of soil organisms and substances synthesized by the soil population. It is determined on soils that have been sieved through a 2.0 mm sieve. It is estimated by multiplying the organic carbon by a factor of 1.72.

Outwash - Sediments "washed out" beyond the glacier by flowing water and laid down in thin beds or strata. Particle size may range from boulders to silt.

Ovendry soil - Soil that has been dried at 105 degrees C until it has reached constant weight.

Parent material - The unaltered or essentially unaltered mineral or organic material from which the soil profile develops by pedogenic processes.

Particle size, soil - The grain size distribution of the whole soil including the coarse fraction. It differs from texture, which refers to the fine earth (less than 2mm) fraction only. In addition, textural classes are usually assigned to specific horizons whereas soil family particle-size classes indicate a composite particle size of a part of the control section that may include several horizons. See Textural Triangle at end of Glossary.

The particle-size classes for family groupings are as follows:

Fragmental Stones, cobbles and gravel, with too little fine earth to fill interstices larger than 1 mm.

Sandy-skeletal Particles coarser than 2 mm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the sandy particle-size class.

Loamy-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the loamy particle-size class.

Clayey-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the clayey particle-size class.

Sandy The texture of the fine earth includes sands and loamy sands, exclusive of loamy very fine sand and very fine sand textures; particles 2 mm- 25 cm occupy less than 35% by volume.

Loamy The texture of the fine earth includes loamy very fine sand, very fine sand, and finer textures with less than 35% clay; particles 2 mm-25 cm occupy less than 35% by volume.

Coarse-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Coarse-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Clayey. The fine earth contains 35% or more clay by weight and particles 2mm-25 cm occupy less than 35% by volume.

Fine-clayey. A clayey particle size that has 35-60% clay in the fine earth fraction.

Very-fine-clayey. A clayey particle size that has 60% or more clay in the fine earth fraction.

Ped - An individual soil aggregate such as granule, prism or block formed by natural processes (in contrast with a clod which is formed artificially).

Pedology - Those aspects of soil science involving constitution, distribution, genesis and classification of soils.

Percolation - The downward movement of water through soil; specifically, the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of 1.0 or less.

Permafrost -

1. Perennially frozen material underlying the solum.

2. A perennially frozen soil horizon.

Permafrost table - The upper boundary of permafrost, usually coincident with the lower limit of seasonal thaw (active layer).

Permeability - The ease with which water and air pass through the soil to all parts of the profile. See hydraulic conductivity.

pH - The intensity of acidity and alkalinity, expressed as the negative logarithm of the hydrogen ion concentration. A pH of 7 is neutral, lower values indicate acidity and higher values alkalinity (see Reaction, soil).

Phase, soil - A soil phase is used to characterize soil and landscape properties that are not used as criteria in soil taxonomy. The major phase differentiae are: slope, erosion, deposition, stoniness, texture, salinity, and calcareousness.

Plastic Limit - The water content corresponding to an arbitrary limit between the plastic and the semisolid states of consistency of a soil.

Plasticity Index - The numerical difference between the liquid and the plastic limit. The plasticity index gives the range of moisture contents within which a soil exhibits plastic properties.

Potential evapotranspiration (PE) - The maximum quantity of water capable of being lost as water vapor, in a given climate, by a continuous stretch of vegetation covering the whole ground and well supplied with water.

Profile, soil - A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil - The acidity or alkalinity of a soil. Soil reaction classes are characterized as follows:

extremely acid	pH <4.5
very strongly acid	4.5 to 5.0
strongly acid	5.1 to 5.5
medium acid	5.6 to 6.0
slightly acid	6.1 to 6.5
neutral	6.6 to 7.3
mildly alkaline	7.4 to 7.8
mod. alkaline	7.9 to 8.4
strongly alkaline	8.5 to 9.0
very strongly alkaline	>9.0

Regolith - The unconsolidated mantle of weathered rock and soil material on the earth's surface.

Relief - The elevation of inequalities of the land surface when considered collectively.

Runoff - The portion of the total precipitation on an area that flows away through stream channels. Surface runoff does not enter the soil. Groundwater runoff or seepage flow from groundwater enters the soil before reaching the stream.

Saline Soil - A nonalkali soil containing soluble salts in such quantities that they interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 millisiemens/cm (ms/cm), the exchangeable-sodium percentage is less than 15, and the pH is usually less than 8.5. Approximate limits of salinity classes are:

non-saline	0 to 4 ms/cm
weakly saline	4 to 8 mS/cm
mod. saline	8 to 15 ms/cm
strongly saline	>15 ms/cm

Salinization - The process of accumulation of salts in the soil.

Salt-Affected Soil - Soil that has been adversely modified for the growth of most crop plants by the presence of certain types of exchangeable ions or of soluble salts. It includes soils having an excess of salts, or an excess of exchangeable sodium or both.

Sand - A soil particle between 0.05 and 2.0 mm in diameter. The textural class name for any soil containing 85 percent or more of sand and not more than 10 percent of clay.

Saturation Percentage - The moisture percentage of a saturated soil paste, expressed on an oven dry weight basis.

Seepage -

1. The escape of water downward through the soil.

2. The emergence of water from the soil along an extensive line of surface in contrast to a spring where water emerges from a local spot.

Series, soil - A category in the Canadian System of Soil Classification. It consists of soils that have soil horizons similar in their differentiating characteristics and arrangement in the profile, except for surface texture and are formed from a particular type of parent material.

Shrinkage limit - This is the moisture content at which an equilibrium condition of volume change is reached and further reduction in moisture content will not cause a decrease in the volume of the soil mass.

Shrinkage ratio - This is the ratio between the volume change and a corresponding change in moisture content. It equals the apparent specific gravity of the dried soil.

Silt - (a) Individual mineral particles of soil that range in diameter between 0.05 to .002 mm. (b) Soil of the textural class silt contains greater than 80 percent silt and less than 12 percent clay.

Slickenside - Smoothed surfaces along planes of weakness resulting from the movement of one mass of soil against another in soils dominated by swelling clays.

Sodium-Adsorption Ratio (S.A.R.) - A ratio for soil extracts and irrigation waters used to express the relative activity of sodium ions in exchange reactions with other cations in the soil SAR = $Na/((Ca+Mg)/2)^{1/2}$ where the cation concentrations are expressed as milliequivalents per litre.

Soil - The unconsolidated mineral material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Soil has been subjected to and influenced by genetic and environmental factors of: parent material, climate (including moisture and temperature effects), macro- and microorganisms, and topography, all acting over a period of time.

Solum - The upper horizons of a soil above the parent material and in which the processes of soil formation are active. It usually comprises the A and B horizons.

Stones - Rock fragments greater than 25 cm in diameter.

Stoniness - The percentage of land surface occupied by stones. The classes of stoniness are defined as follows:

Stones 0. Nonstony -- Land having less than 0.01% of surface occupied by stones.

Stones 1. Slightly stony -- Land having 0.01-0.1% of surface occupied by stones. Stones 15-30 cm in diameter, 10-30 m apart. The stones offer only slight to no hindrance to cultivation.

Stones 2. Moderately stony -- Land having 0.1-3% of surface occupied by stones. Stones 15-30 cm in diameter, 2-10 m apart. Stones cause some interference with cultivation.

Stones 3. Very stony -- Land having 3-15% of surface occupied by stones. Stones 15-30 cm in diameter, 1-2 m apart. There are sufficient stones to constitute a serious handicap to cultivation.

Stones 4. Exceedingly stony -- Land having 15-50% of surface occupied by stones. Stones 15-30 cm in diameter, 0.7-1.5 m apart. There are sufficient stones to prevent cultivation until considerable clearing has been done.

Stones 5. Excessively stony -- Land having more than 50% of surface occupied by stones. Stones 15-30 cm in diameter, less than 0.7 m apart. The land is too stony to permit cultivation.

Storage Capacity - Refers to the maximum amount of readily available water that can be stored within the rooting zone of a crop in a given soil. For practical irrigation purposes, 50 percent of the total soil water between field capacity and wilting point may be considered as readily available.

Stratified materials - Unconsolidated sand, silt and clay arranged in strata or layers. In stratified materials, a bed is a unit layer distinctly separable from other layers and is one or more cm thick but a lamina is a similar layer less than 1 cm thick.

Structure - The combination or arrangement of primary soil particles into aggregates of secondary soil particles, units or peds, which are separated from each other by surfaces of weakness. Structure is expressed in terms of grade, size class and shape type. Grade refers to the distinctness of aggregate development, and is described as structureless, weak, moderate or strong. Structureless refers to the absence of observable aggregation of definite orderly arrangement; the term amorphous is used if soil is massive or coherent, single-grained if noncoherent. The weak to strong aggregates vary in size and are described by class as fine, medium, coarse, and very coarse depending on the shape types. The shape types refers to the dominant configuration of the aggregates and the way they are accommodated. The general shape types are plate-like, block-like and prism-like. The terms are:

Platy - Having thin, plate-like aggregates with faces mostly horizontal

Prismatic - Having prism-like aggregates with tops and edges, appear plane, level and somewhat angular.

Columnar - Having prism-like aggregates with vertical edges near the top of columns, not sharp.

Granular - Having block-like aggregates that appear as spheroids or polyhedrons having plane or curved surfaces which have slight or no accommodation to the faces of the surrounding peds.

Blocky - Having block-like aggregates with sharp, angular corners

Subangular blocky - Having block-like aggregates with rounded and flattened faces and rounded corners.

By convention an aggregate is described in the order of grade, class and type, e.g. strong, medium, blocky. In the parent material of soils the material with structural shapes may be designated as pseudo-blocky, pseudo-platy, etc.

Soil Survey - The systematic examination, description, classification, and mapping of soil in an area.

Sulfate Hazard - Refers to the relative degree of attack on concrete by soil and water containing various amounts of sulfate ions. It is estimated from electrolyte measurements and salt analysis on selected profiles and soil samples, and by visual examination of free gypsum within the profile during the course of soil investigation.

Swamp - See Description of Landforms

Texture, soil - The relative proportions of the fine earth (less than 2 mm.) fraction of a soil. Textural classes are usually assigned to specific horizons whereas family particle size classes indicate a composite particle size of a portion of the control section that may include several horizons. See Texture Triangle at end of Glossary.

The size range of the constituent primary particles are as follows:

	Diameter (mm)
Very coarse sand	2.0-1.0
Coarse sand	1.0-0.5
Medium sand	0.5-0.25
Fine sand	0.25-0.10
Very fine sand	0.10-0.05
Silt	0.05-0.002
Clay	< 0.002
Fine clay	< 0.0002

Till, glacial - Unstratified glacial deposits consisting of clay, sand, gravel, and boulders intermingled in any proportion.

Tilth - The physical condition of soil as related to its ease of tillage, fitness as a seedbed, and its impedance to seedling emergency and root penetration.

Topography - Refers to the percent slope and the pattern or frequency of slopes in different directions. A set of 10 slope classes are used to denote the dominant but not necessarily most abundant slopes within a mapping unit.

Slope Class	Slope Name	Percent slope	Approx. degrees
1	level	0-0.5	0
2	nearly level	.5-2.5	.3-1.5
3	very gentle	2-5	1-3
4	gentle	6-9	3.5-5
5	moderate	10-15	6-8.5
6	strong	16-30	9-17
7	very strong	31-45	17-24
8	extreme	46-70	25-35
9	steep	71-100	35-45
10	very steep	>100	>45

Underground runoff - (or seepage)-Water flowing towards stream channels after infiltration into the ground.

Unified Soil Classification System (engineering) - A classification system based on the identification of soils according to their particle size, gradation, plasticity index and liquid limit.

Urban Land - Areas so altered or obstructed by urban works or structures that identification of soils is not feasible.

Variant, soil - A soil whose properties are believed to be sufficiently different from other known soils to justify a new series name, but comprising such a limited geographic area that creation of a new series is not justified.

Varve - A distinct band representing the annual deposit in sedimentary materials regardless of origin and usually consisting of two layers, one thick light colored layer of silt and fine sand laid

down in the spring and summer, and the other a thin, dark colored layer of clay laid down in the fall and winter.

Water balance, soil - Is the daily amount of readily available water retained by the soil. The daily soil-water balance is decreased by the amount that the daily consumptive use exceeds the daily rainfall. When daily rainfall exceeds the consumptive use, the daily balance increases by the amount of the difference unless the soil-water balance is at storage capacity, in which case the excess is assumed to be lost by runoff or deep percolation.

Water table - (groundwater surface; free water surface; groundwater elevation) Elevation at which the pressure in the water is zero with respect to the atmospheric pressure.

Water-holding capacity - The ability of a soil to hold water against the force of gravity in a freely drained soil.

Weathering - The physical and chemical disintegration, alteration and decomposition of rocks and minerals at or near the earth's surface by atmospheric agents.

Xerophyte - Plants capable of surviving extended periods of soil drought.

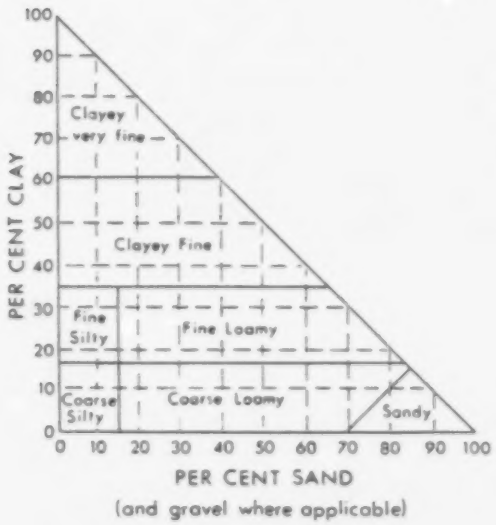
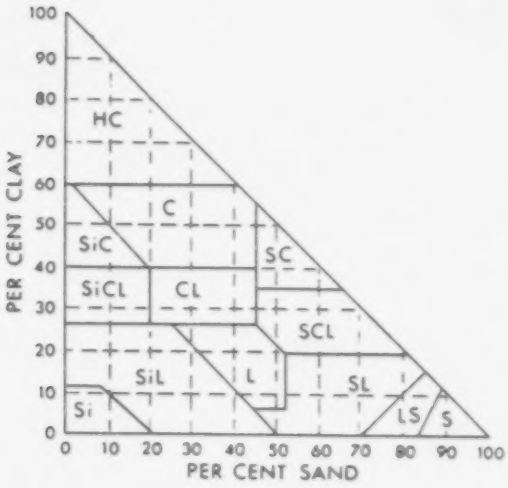


Figure 6: Family particle-size classes.



Texture Group	Class Symbol	Class Name
Coarse	S	sand
	LS	loamy sand
Moderately coarse	SL	sandy loam
	LVFS	loamy very fine sand
Medium	Si	silt
	SiL	silt loam
	L	loam
	VFSL	very fine sandy loam
Moderately fine	SCL	sandy clay loam
	CL	clay loam
	SiCL	silty clay loam
Fine	SC	sandy clay
	C	clay
	SiC	silty clay
Very fine	HC	heavy clay

Figure 7: Soil Textural Classes.

Appendix B

SOIL HORIZON DESIGNATIONS

ORGANIC HORIZONS

Organic horizons are found in Organic soils, and commonly at the surface of mineral soils. They may occur at any depth beneath the surface in buried soils, or overlying geologic deposits. They contain more than 17% organic carbon (approximately 30% organic matter) by weight. Two groups of these horizons are recognized, O horizons and the L, F, and H horizons.

O This is an organic horizon developed mainly from mosses, rushes, and woody materials.

Of The fibric horizon is the least decomposed of all the organic soil materials. It has large amounts of well-preserved fiber that are readily identifiable as to botanical origin. A fibric horizon has 40% or more of rubbed fiber by volume and a pyrophosphate index of 5 or more. If the rubbed fiber volume is 75% or more, the pyrophosphate criterion does not apply.

Om The mesic horizon is the intermediate stage of decompostion with intermediate amounts of fiber, bulk density and water-holding capacity. The material is partly altered both physically and biochemically. A mesic horizon is one that fails to meet the requirements of fibric or humic.

Oh The humic horizon is the most highly decomposed of the organic soil materials. It has the least amount of fiber, the highest bulk density, and the lowest saturated water-holding capacity. It is very stable and changes very little physically or chemically with time unless it is drained. The humic horizon has less than 10% rubbed fiber by volume and a pyrophosphate index of 3 or less.

LFH These organic horizons developed primarily from leaves, twigs, woody materials and a minor component of mosses under imperfectly to well drained forest conditions.

L This is an organic horizon characterized by an accumulation of organic matter in which the original structures are easily discernible.

F This is an organic horizon characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The horizon may be partly comminuted by soil fauna as in moder, or it may be a partly decomposed mat permeated by fungal hyphae as in mor.

H This is an organic horizon

characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible. This material differs from the F horizon by its greater humification chiefly through the action of organisms. It is frequently intermixed with mineral grains, especially near the junction with the mineral horizon.

MASTER MINERAL HORIZONS

Mineral horizons are those that contain less than 30% organic matter by weight as specified for organic horizons.

A This is a mineral horizon or horizons formed at or near the surface in the zone of leaching or removal of materials in solution and suspension or of maximum in situ accumulation of organic matter, or both. Included are:

1. horizons in which organic matter has accumulated as a result of biological activity (Ah);

2. horizons that have been eluviated of clay, iron, aluminum, or organic matter, or all of them (Ae);

3. horizons having characteristics of 1) and 2) above but transitional to underlying B or C (AB or A and B);

4. horizons markedly disturbed by cultivation or pasture (Ap).

B This is a mineral horizon or horizons characterized by one or more of the following:

1. an enrichment in silicate clay, iron, aluminum, or humus, alone or in combination (Bt,Bf,Bfh,Bhf, and Bh);

2. a prismatic or columnar structure that exhibits pronounced coatings or stainings and significant amount of exchangeable Na (Bn);

3. an alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below, or both, and does not meet the requirements of 1) and 2) above (Bm,Bg).

C This is a mineral horizon or horizons comparatively unaffected by the pedogenic processes operative in A and B, excepting (i) the process of gleying, and (ii) the accumulation of calcium and magnesium carbonates and more soluble salts (Cca,Csa,Cg, and C). Marl and diatomaceous earth are considered to be C horizons.

R This is consolidated bedrock that is too hard to break with the hands or to dig with a spade when moist and that does not meet the requirement of a C horizon. The boundary between the R layer and overlying unconsolidated material is called a lithic contact.

W This is a layer of water in Gleysolic, Organic, or Cryosolic soils. It is called a hydric layer in Organic soils.

LOWER-CASE SUFFIXES

b Buried soil horizon.

c A cemented (irreversible) pedogenic horizon. The ortstein of a Podzol, and a layer cemented by

calcium carbonate and a duripan are examples.

ca A horizon with secondary carbonate enrichment where the concentration of lime exceeds that present in the unenriched parent material. It is more than 10 cm thick, and if it has a CaCO3 equivalent of less than 15 percent it should have at least 5 percent more CaCO3 equivalent than the parent material (IC). If it has more than 15 percent CaCO3 equivalent it should have 1/3 more CaCO3 equivalent than the IC. If no IC is present, this horizon is more than 10 cm thick and contains more than 5 percent by volume of secondary carbonates in concretions or soft, powdery forms.

cc Cemented (irreversible) pedogenic concretions.

e A horizon characterized by the eluviation of clay, iron, aluminum, or organic matter alone or in combination. When dry, it is usually higher in color value by 1 or more units than an underlying B horizon. It is used with A (Ae).

f A horizon enriched with amorphous material, principally Al and Fe combined with organic matter. It usually has a hue of 7.5YR or redder or its hue is 10YR near the upper boundary and becomes yellower with depth. When moist, the chroma is higher than 3 or the value is 3 or less. It contains 0.6% or more pyrophosphate-extractable Al+Fe in textures finer than sand and 0.4% or more in sands (coarse sand, sand, fine sand, and very fine sand). The ratio of pyrophosphate-extractable Al+Fe to clay (less than 0.002mm) is more than 0.05 and organic C exceeds 0.5%. Pyrophosphate-extractable Fe is at least 0.3%, or the ratio of organic C to pyrophosphate-extractable Fe is less than 20, or both are true. It is used with B alone (Bf), with B and h (Bhf), with B and g (Bfg), and with other suffixes. The criteria for "f" do not apply to Bgf horizons. The following horizons are differentiated on the basis of organic carbon content: Bf - 0.5% to 5% organic carbon. Bhf- more than 5% organic carbon.

g A horizon characterized by gray colors, or prominent mottling, or both, indicative of permanent or periodic intense reduction. Chromas of the matrix are generally 1 or less. It is used with A and e (Aeg); with B alone (Bg); with B and f (Bfg); with B, h, and f (Bhfg); with B and t (Btg); with C alone (Cg); with C and k (Ckg); and several others. In some reddish parent materials, matrix colors of reddish hues and high chromas may persist despite long periods of reduction. In these soils, horizons are designated as g if there is gray mottling or if there is marked bleaching on ped faces or along cracks.

Aeg This horizon must meet the definitions of A,e, and g.

Bg These horizons are analogous to Bm horizons but they have colors indicative of poor drainage and periodic reduction. They include horizons occurring between A and C horizons in which the main features are (i) colors of low chroma, that is: chromas of 1 or less, without mottles on ped surfaces or in the matrix if peds are lacking; or chromas of 2 or less in hues of 10YR or redder, on

ped surfaces or in the matrix if peds are lacking, accompanied by more prominent mottles than those in the C horizon; or hues bluer than 10Y, with or without mottles on ped surfaces or in the matrix if peds are lacking. (ii) colors indicated in (i) and a change in structure from that of the C horizons. (iii) color indicated in (i) and illuviation of clay too slight to meet the requirements of Bt; or accumulation or iron oxide too slight to meet the limits of Bgf. (iv) colors indicated in (i) and removal of carbonates. Bg horizons occur in some Orthic Humic Gleysols and some Orthic Gleysols.

Bfg, Bhfg, Btg, and others. When used in any of these combinations the limits set for f, hf, t, and others must be met.

Bgf The dithionite-extractable Fe of this horizon exceeds that of the IC by 1% or more. Pyrophosphate-extractable Al + Fe is less than the minimum limit specified for 'f' horizons. This horizon occurs in Fera Gleysols and Fera Humic Gleysols, and possibly below the Bfg of gleyed Podzols. It is distinguished from the Bfg of gleyed Podzols on the basis of the extractability of the Fe and Al. The Fe in the Bgf horizon is thought to have accumulated as a result of the oxidation of ferrous iron. The iron oxide formed is not associated intimately with organic matter or with Al, and it is sometimes crystalline. The Bgf horizons are usually prominently mottled, with more than half of the soil material occurring as mottles of high chroma.

Cg, Ckg, Ccag, Csg, Csag. When g is used with C alone, or with C and one of the lower-case suffixes k, ca, s, or sa, it must meet the difinition for C and for the particular suffix.

h A horizon enriched with organic matter. It is used with A alone (Ah); or with A and e (Ahe); or with B alone (Bh); or with B and f (Bhf).

Ah A horizon enriched with organic matter that either has a color value at least one unit lower than the underlying horizon or contains 0.5% more organic carbon than the IC, or both. It contains less than 17% organic carbon by weight.

Ahe An Ah horizon that has undergone eluviation as evidenced, under natural conditions, by streaks and splotches of differing shades of gray and often by platy structure. It may be overlain by a darker-colored Ah and underlain by a lighter-colored Ae.

Bh This horizon contains more than 1% organic carbon, less than 0.3% pyrophosphate-extractable Fe, and has a ratio of organic carbon to pyrophosphate-extractable Fe of 20 or more. Generally the color value

and chroma are less than 3 when moist.

Bhf Defined under 'f'.

j Used as a modifier of the suffixes e, f, g, n, and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies. It must be placed to the right and adjacent to the suffix it modifies. For example Bfgj means a Bf horizon with weak expression of gleying; Bfjgj means a B horizon with weak expression of both 'f' and 'g' features.

Aej It denotes an eluvial horizon that is thin, discontinuous or slightly discernible.

Btj It is a horizon with some illuviation of clay, but not enough to meet the limits of Bt.

Btgj, Bmgj. Horizons that are mottled but do not meet the criteria of Bg.

Bfj It is a horizon with some accumulation of pyrophosphate-extractable Al and Fe but not enough to meet the limits of Bf.

Bntj or Bnj. Horizons in which development of solonetzic B properties is evident but insufficient to meet the limits for Bn or Bnt.

k Denotes the presence of carbonate, as indicated by visible effervescence when dilute HCl is added. Most often it is used with B and m (Bmk) or C (Ck), and occasionally with Ah or Ap (Ahk, Apk), or organic horizons (Ofk, Omk).

m A horizon slightly altered by hydrolysis, oxidation, or solution, or all three, to give a change in color or structure, or both. It has:

1. Evidence of alteration in one of the following forms:

   a) Higher chromas and redder hues than the underlying horizons.

   b) Removal of carbonates, either partially (Bmk) or completely (Bm).

2. Illuviation, if evident, too slight to meet the requirements of a Bt or a podzolic B.

3. Some weatherable minerals.

4. No cementation or induration and lacks a brittle consistence when moist. This suffix can be used as Bm, Bmgj, Bmk, and Bms.

n A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. It must also have the following distinctive morphological characteristics: prismatic or columnar structure, dark coatings on ped surfaces, and hard to very hard consistence when dry. It is used with B, as Bn or Bnt.

p A horizon disturbed by man's activities, such as cultivation, logging, habitation, etc. It is used with A and O.

s A horizon with salts, including gypsum, which may be detected as crystals or veins, as surface crusts of salt crystals, by depressed crop growth, or by the presence of salt-tolerant plants. It is commonly used with C and k (Csk), but can be used with any

horizon or combination of horizon and lowercase suffix.

sa A horizon with secondary enrichment of salts more soluble than calcium and magnesium carbonates, in which the concentration of salts exceeds that present in the unenriched parent material. The horizon is 10 cm or more thick. The conductivity of the saturation extract must be at least 4 ms/cm and must exceed that of the C horizon by at least one-third.

t An illuvial horizon enriched with silicate clay. It is used with B alone (Bt), with B and g (Btg), with B and n (Bnt), etc.

Bt A Bt horizon is one that contains illuvial layer-lattice clays. It forms below an eluvial horizon, but may occur at the surface of a soil that has been partially truncated. It usually has a higher ratio of fine clay to total clay than IC. It has the following properties:

1. If any part of an eluvial horizon remains and there is no lithologic discontinuity between it and the Bt horizon, the Bt horizon contains more total and fine clay than the eluvial horizons, as follows:

   a) If any part of the eluvial horizon has less than 15% total clay in the fine earth fraction (2mm) the Bt horizon must contain at least 3% more clay, e.g.,Ae 10% clay-Bt minimum 13% clay.

   b) If the eluvial horizon has more than 15% and less than 40% total clay in the fine earth fraction, the ratio of the clay in the Bt horizon to that in the eluvial horizon must be 1.2 or more, e.g., 20% clay increase in the Bt over Ae.

   c) If the eluvial horizon has more than 40% total clay in the fine earth fraction, the Bt horizon must contain at least 8% more clay than the eluvial horizon, e.g. Ae 50% clay; Bt at least 58% clay.

2. A Bt horizon must be at least 5 cm thick. In some sandy soils where clay accumulation occurs in the lamellae, the total thickness of the lamellae should be more than 10 cm in the upper 150 cm of the profile.

3. In massive soils the Bt horizon should have oriented clays in some pores and also as bridges between the sand grains.

4. If peds are present, a Bt horizon shows clay skins on some of the vertical and horizontal ped surfaces and in the fine pores, or shows oriented clays in 1% or more of the cross section, as viewed in thin section.

5. If a soil shows a lithologic discontinuity between the eluvial horizon and the Bt horizon, or if only a plow layer overlies the Bt horizon, the Bt horizon need show only clay skins in some part, either in some fine pores or on some vertical and horizontal ped surfaces. Thin sections should show that some part of the horizon has about 1% or more of oriented clay bodies.

Btj, Btj, and Btg are defined under j and g.

u A horizon that is markedly disrupted by physical or faunal processes other than cryoturbation. Evidence of marked disruption such as the inclusion of material from other horizons, absence of the horizon, etc. must be evident in at least half of the cross section of the pedon. Such turbation can result from blowdown of trees, mass movement of soil on slopes, and burrowing animals. It can be used with any horizon or subhorizon with the exception of A or B alone; e.g. Aeu, Bfu, BCu.

x A horizon of fragipan character. A fragipan is a loamy subsurface horizon of high bulk density and very low organic matter content. When dry, it has a hard consistence and seems to be cemented. When moist, it has moderate to weak brittleness. It frequently has bleached fracture planes and is overlain by a friable B horizon. Air dry clods of fragic horizons slake in water.

y A horizon affected by cryoturbation as manifested by disrupted and broken horizons,, incorporation of materials from other horizons and mechanical sorting in at least half of the cross section of the pedon. It is used with A, B, and C alone or in combination with other subscripts, e.g. Ahy, Ahgy, Bmy, Cy, Cgy, Cygj, etc.

z A frozen layer. It may be used with any horizon or layer, e.g. Ohz, Bmz, Cz, Wz.

Appendix C

DESCRIPTION OF LANDFORMS

C.1 GENETIC MATERIALS

Unconsolidated mineral component

The unconsolidated mineral component consists of clastic sediments that may or may not be stratified, but whose particles are not cemented together. They are essentially of glacial or post-glacial origin but include poorly consolidated and weathered bedrock.

Anthropogenic - Man-made or man-modified materials, including those associated with mineral exploitation and waste disposal.

Colluvial - Massive to moderately well stratified, nonsorted to poorly sorted sediments with any range of particle sizes from clay to boulders and blocks that have reached their present position by direct, gravity-induced movement.

They are restricted to products of mass-wasting whereby the debris is not carried by wind, water, or ice (excepting snow avalanches).

Eolian - Sediment, generally consisting of medium to fine sand and coarse silt particle sizes, that is well sorted, poorly compacted, and may show internal structures such as cross bedding or ripple laminae, or may be massive. Individual grains may be rounded and show signs of frosting.

These materials have been transported and deposited by wind action.

Fluvial - Sediment generally consisting of gravel and sand with a minor fraction of silt and clay. The gravels are typically rounded and contain interstitial sand. Fluvial sediments are commonly moderately to well sorted and display stratification, but massive, nonsorted fluvial gravels do occur. These materials have been transported and deposited by streams and rivers. Finer textured Fluvial deposits of modern rivers are termed Alluvium.

Lacustrine - Sediment generally consisting of either stratified fine sand, silt, and clay deposited on the lake bed; or moderately well sorted and stratified sand and coarser materials that are beach and other nearshore sediments transported and deposited by wave action.

These are materials that either have settled from suspension in bodies of standing fresh water or have accumulated at their margins through wave action.

Marine - Unconsolidated deposits of clay, silt, sand, or gravel that are well to moderately well sorted and well stratified to moderately stratified (in some places containing shells). They have settled from suspension in salt or brackish water bodies or have

accumulated at their margins through shoreline processes such as wave action and longshore drift.

Morainal - Sediment generally consisting of well compacted material that is nonstratified and contains a heterogeneous mixture of particle sizes, often in a mixture of sand, silt, and clay that has been transported beneath, beside, on, within and in front of a glacier and not modified by any intermediate agent.

Saprolite - Rock containing a high proportion of residual silts and clays formed by alteration, chiefly by chemical weathering.

The rock remains in a coherent state, interstitial grain relationships are undisturbed and no downhill movement due to gravity has occurred.

Undifferentiated - A layered sequence of more than three types of genetic material outcropping on a steep erosional escarpment.

Volcanic - Unconsolidated pyroclastic sediments. These include volcanic dust, ash, cinders, and pumice.

Qualifying Descriptors

These have been introduced to qualify the genetic materials and to supply additional information about the mode of formation or depositional environment.

Glacial - Used to qualify nonglacial genetic materials or process modifiers where there is direct evidence that glacier ice exerted a strong but secondary or indirect control upon the mode of origin of the materials or mode of operation of the process. The use of this qualifying descriptor implies that glacier ice was close to the site of the deposition of a material or the site of operation of a process.

Glaciofluvial - Fluvial materials showing clear evidence of having been deposited either directly in front of or in contact with glacier ice.

Glaciolacustrine - Lacustrine materials deposited in contact with glacial ice.

Glaciomarine - Materials of glacial origin laid down in a marine environment, as a result of settling from melting, floating ice and ice shelves.

Organic component

The organic component consists of peat deposits containing >30% organic matter by weight that may be as thin as 10 cm if they overlie bedrock but are otherwise greater than 40 cm and generally greater than 60 cm thick. The classes and their definitions follow.

B	Bog
N	Fen
S	Swamp

Bog - A bog is a peat-covered or peat-filled area, generally with a high water table. Since the surface of the peatland is slightly elevated, bogs are either unaffected or partly affected by nutrient-rich groundwaters from the surrounding mineral soils. The groundwater is generally acidic and low in nutrients (ombrotrophic). The dominant peat materials are sphagnum and forest peat, underlain, at times, by fen peat.

Fen - A fen is a peat-covered or peat-filled area with a high water table, which is usually at the surface. The dominant materials are shallow to deep, well to moderately decomposed fen peat. The waters are mainly rich in nutrients (minerotrophic) and are derived from mineral soils. The peat materials are therefore higher in both nutrients and pH than the peats associated with bogs.

Swamp - A swamp is a peat-covered or peat-filled area. The peat surface is level or slightly concave in cross section. The water table is frequently at or above the peat surface. There is strong water movement from margins or other mineral sources. The microrelief is hummocky, with many pools present. The waters are neutral or slightly acid. The dominant peat materials are shallow to deep mesic to humic forest and fen peat.

C.2 GENETIC MATERIAL MODIFIERS

Material modifiers are used to qualify unconsolidated mineral and organic deposits. Particle-size classes serve to indicate the size, roundness, and sorting of unconsolidated mineral deposits. Fiber classes indicate the degree of decomposition and fiber size of organic materials.

Particle size classes for unconsolidated mineral materials

Blocky: An accumulation of angular particles greater than 256 mm in size.

Bouldery: An accumulation of rounded particles greater than 256 mm in size.

Clayey: An accumulation of particles where the fine earth fraction contains 35% or more clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Cobbly: An accumulation of rounded particles having a diameter of 64-256 mm.

Gravelly: An accumulation of rounded particles ranging in size from pebbles to boulders.

Loamy: An accumulation of particles of which fine earth fraction contains 35% or less clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Pebbly: An accumulation of rounded particles having a diameter of 2-64 mm.

Rubbly: An accumulation of angular fragments having a diameter of 2-256 mm.

Sandy: An accumulation of particles of which the fine earth fraction contains more than 70% by weight of fine sand or coarser particles. Particles greater than 2 mm occupy less than 35% by volume.

Silty: An accumulation of particles of which the fine earth fraction contains less than 15% of fine sand or coarser particles and has less than 35% clay. Particles greater than 2 mm occupy less than 35% by volume.

Fiber classes for organic materials

The amount of fiber and its durability are important characterizing features of organic deposits in that they reflect on the degree of decomposition of the material. The prevalence of woody materials in peats is also of prime importance.

Fibric: The least decomposed of all organic materials; there is a large amount of well-preserved fiber that is readily identifiable as to botanical origin. Fibers retain their character upon rubbing.

Mesic: Organic material in an intermediate stage of decompostion; intermediate amounts of fiber are present that can be identified as to their botanical origin.

Humic: Highly decomposed organic material; small amounts of fiber are present that can be identified as to their botanical origin. Fibers can be easily destroyed by rubbing.

Woody: Organic material containing more than 50% of woody fibers.

C.3 SURFACE EXPRESSION

The surface expression of genetic materials is their form (assemblage of slopes) and pattern of forms. Form as applied to unconsolidated deposits refers specifically to the product of the initial mode of origin of the materials. When applied to consolidated materials, form refers to the product of their modification by geological processes. Surface expression also indicates the manner in which unconsolidated genetic materials relate to the underlying unit.

Consolidated and Unconsolidated mineral surface classes

Apron - A relatively gentle slope at the foot of a steeper slope and formed by materials from the steeper, upper slope.

Blanket - A mantle of unconsolidated materials thick enough to mask minor irregularities in the underlying unit but still conforming to the general underlying topography.

Fan - A fan-shaped form similar to the segment of a cone and having a perceptible gradient from the apex to the toe.

Hummocky - A very complex sequence of slopes extending from somewhat rounded depressions or kettles of various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls or depressions. Slopes are generally 9-70% (5-35 degrees).

Inclined - A sloping, unidirectional surface with a generally constant slope not broken by marked irregularities. Slopes are 2-70% (1-35 degrees). The form of inclined slopes is not related to the initial mode of origin of the underlying material.

Level - A flat or very gently sloping, unidirectional surface with a generally constant slope not broken by marked elevations and depressions. Slopes are generally less than 2% (1 degree).

Rolling - A very regular sequence of moderate slopes extending from rounded, sometimes confined concave depressions to broad, rounded convexities producing a wave-lake pattern of moderate relief. Slope length is often 1.6 km or

greater and gradients are greater than 5% (3 degrees).

Ridged - A long, narrow elevation of the surface, usually sharp crested with steep sides. The ridges may be parallel, subparallel, or intersecting.

Steep - Erosional slopes, greater than 70% (35 degrees), on both consolidated and unconsolidated materials. The form of a steep erosional slope on unconsolidated materials is not related to the initial mode of origin of the underlying material.

Terraced - Scarp face and the horizontal or gently inclined surface (tread) above it.

Undulating - A very regular sequence of gentle slopes that extends from rounded, sometimes confined concavities to broad rounded convexities producing a wavelike pattern of low local relief. Slope length is generally less than 0.8 km and the dominant gradient of slopes is 2-5% (1-3 degrees).

Veneer - Unconsolidated materials too thin to mask the minor irregularities of the underlying unit surface. A veneer will range from 10 cm to 1 m in thickness and will possess no form typical of the material's genesis.

Organic surface classes

Blanket - A mantle of organic materials that is thick enough to mask minor irregularities in the underlying unit but still conforms to the general underlying topography.

Bowl - A bog or fen occupying concave-shaped depressions.

Domed - A bog with an elevated, convex, central area much higher than the margin. Domes may be abrupt (with or without a frozen core) or gently sloping or have a stepped surface.

Floating - A level organic surface associated with a pond or lake and not anchored to the lake bottom.

Horizontal - A flat peat surface not broken by marked elevations and depressions.

Plateau - A bog with an elevated, flat, central area only slightly higher than the margin.

Ribbed - A pattern of parallel or reticulate low ridges associated with fens.

Sloping - A peat surface with a generally constant slope not broken by marked irregularities.

Veneer - A thin (40 cm-1m) mantle of organic materials which generally conforms to the underlying topography. They may or may not be associated with discontinuous permafrost.

Appendix D

SOIL CORRELATION OF THE SOUTH ASSINIBOINE AREA RESURVEY WITH THE SOILS IN THE RECONNAISSANCE SOIL SURVEYS OF THE CARBERRY MAP SHEET AREA, REPORT NO. 7, 1957, AND THE SOUTH-CENTRAL MAP SHEET AREA, REPORT NO. 4, 1943

The South Assiniboine River soil study includes portions of the Reconnaissance Soil Surveys of the Carberry and South-Central Map Sheets. The northern part of the resurvey area lies within the Carberry Map Sheet while the southern part lies in the South-Central Map Sheet. This resurvey benefits from advantages derived from more frequent and intensive examination of soils in the field, use of a larger mapping scale to permit delineation of numerous important local soils, use of modern aerial photographs and use of improved methods of studying soils in the laboratory. In particular, differences in the stratigraphy of surface deposits, depth and type of soil profile, degree of erosion, slope, stoniness and salinity are emphasized.

In the reconnaissance maps of the South-Central and Carberry Map Sheet Areas each unit shown is a compound unit consisting of a complex of soil types known as a "soil association", having a dominant soil type interspersed with related but unlike local soil types in lesser proportion. While soil associations are shown as units on the reconnaissance map, local associated soils, textural classes and phases are occasionally mapped and designated as separate units where areas involved are substantial or where such units are of sufficient local importance. In some instances, such units are identified on the reconnaissance map by site symbols or hatching. The individual associated soils developed on similar kinds of soil parent material are referred as "soil associates". They are recognized by differences in their soil profile characteristics as a result of differences in topographical position, drainage and vegetation, namely, variation in local climate.

In the present detailed map of the South Assiniboine area, each unit shown is either a simple unit consisting of a single soil type referred to as a "soil series" or a specifically defined compound unit containing one dominant soil series and usually one other related but unlike soil series associated with it. Soil series in terms of current Canadian Soil Classification criteria (CSSC 1978) are approximately equivalent to soil associates as defined in the 1943 and 1957 studies. In general, the range in allowable variation in profile characteristics and properties of soil series is significantly less than the range permitted in so-called soil associates.

The detailed resurvey of the South Assiniboine study area provides for improved reliability of the soil map for a variety of interpretive applications. Correlation of the soil series in the South Assiniboine resurvey with soil associations and soil associates of the Reconnaissance Surveys of the South-Central and Carberry Map Sheet Areas is provided in Table 10.

Table 10. Correlation of Soil Series in the South Assiniboine River Study Area with Soil Associations and Associates of the South-Central Reconnaissance Survey Map, Report No. 4 (1943) and the Carberry Map Sheet Area, Report No. 7 (1957).

Soil Symbol	Present Soil Series Name	Subgroup	Soil Association or Associate Carberry Map Sheet (1957)	Soil Association or Associate South-Central Map Sheet (1943)	Remarks
AIZ	Arizona	Orthic Regosol	Stockton	Stockton	The well to excessively drained, droughty, eroded, Black associate of the Stockton sand and loamy sand in the Carberry and South-Central sheets.
BKR	Basker	Rego Humic Gleysol	Assiniboine Complex	Assiniboine Complex	The same as the poorly drained, loam to heavy loam, immature soil associate of the Assiniboine Complex
CAV	Carvey	Rego Humic Gleysol	Marringhurst, Miniota, Agassiz	Marringhurst, Agassiz	The poorly drained meadow associate of these Associations with a significantly thicker and finer textured surface horizon.
CKD	Crookdale	Gleyed Rego Black	Wellwood	Glenboro	The same as the Black-Meadow associate of the Wellwood Association in the Carberry sheet and the imperfectly drained Glenboro clay loam in the South-Central sheet.
CYN	Croyon	Orthic Black	Marringhurst, Miniota, Agassiz	Marringhurst, Agassiz	A significant inclusion in these Associations with a finer loam to clay loam surface texture. The well drained Blackearth associate.
CXT	Capell	Gleyed Rego Black	Marringhurst, Miniota, Agassiz	Marringhurst, Agassiz	The imperfectly drained, Black-Meadow associate of the Miniota, Marringhurst and Agassiz Associations, having a finer textured surface layer over sand and gravel.
CXV	Charman	Gleyed Black	Carroll	Carroll	A significant inclusion in the Carroll Association, the imperfectly drained Black-Meadow associate of the Carroll clay loam to silty clay loam.

Table 10 Cont'd

Soil Symbol	Present Soil Series Name	Subgroup	Soil Association or Associate Carberry Map Sheet (1957)	Soil Association or Associate South-Central Map Sheet (1943)	Remarks
DOT	Dorset	Orthic Black	Marringhurst, Agassiz	Marringhurst, Agassiz	The same as the typical or dominant Blackearth soil of the Marringhurst and Agassiz Associations.
DXM	Druxman	Gleyed Black	Marringhurst, Miniota, Agassiz	Marringhurst, Agassiz	The imperfectly drained, Blackearth-Meadow associate of these Associations, differing by having a finer textured surface horizon.
ERX	Eroded Slope Complex		Eroded Slopes	Eroded Slopes	The same as the Eroded Slopes map unit definition in the Carberry and South-Central sheets.
GBO	Glenboro	Orthic Black	Glenboro	Glenboro	Equivalent to the dominant, well drained Blackearth associate of the Glenboro Association in the Carberry and South-Central maps.
GRO	Grover	Gleyed Rego Black	Glenboro	Glenboro	The intermediately drained, Black-Meadow associate of the Glenboro Association, clay loam textural type.
HMO	Hummerston	Gleyed Rego Black	Stockton	Stockton	A significant inclusion in the Stockton Association. The Black-Meadow associate of these loamy sand soils.
HRG	Harding	Gleyed Black	Harding	Assiniboine Complex	The same as the Black-Meadow associate of the Harding clay in the Carberry Sheet. Similar to the somewhat developed, intermediately drained associate of the Assiniboine Complex in the S.C. map.
JIK	Janick	Orthic Black	Harding	Assiniboine Complex	A significant well drained Black associate inclusion in the Harding Association of the Carberry Sheet. In the S.C. Sheet, comparable to the better developed, well drained Blackearth associate of the Assiniboine clay soils.

Table 10. Cont'd

Soil Symbol	Present Soil Series Name	Subgroup	Soil Association or Associate Carberry Map Sheet (1957)	Soil Association or Associate South-Central Map Sheet (1943)	Remarks
LEI	Levine	Gleyed Cumulic Regosol	Assiniboine Complex	Assiniboine Complex	A major inclusion in the Assiniboine Complex. The same as the imperfectly drained, stratified, clay loam to silty clay loam alluvium.
LVH	Lavenham	Gleyed Black	Stockton	Stockton	The imperfectly drained, taxonomic variant of the Black-Meadow associate of the Stockton loamy sands.
MOW	Mowbray	Cumulic Regosol	Assiniboine Complex	Assiniboine Complex	The same as the well drained, loamy, immature soils of the Assiniboine Complex on terraces and floodplains.
MXI	Miniota	Orthic Black	Miniota	Marringhurst, Agassiz	The dominant, Black associate of the Miniota sandy loams in the Carberry sheet. An inclusion in the Marringhurst and Agassiz Associations of the South-Central sheet, the Blackearth associate with a sandy loam surface over sand and gravel.
OBR	Oberon	Gleyed Black	Wellwood	Glenboro	In the Carberry sheet, the same as the Black-Meadow associate of the Wellwood Association. The intermediately drained associate of the Glenboro clay loam in the South-Central sheet.
PDA	Prodan	Gleyed Rego Black	Carroll	Carroll	A significant inclusion in the Carroll (clay loam) Association, the imperfectly drained Black-Meadow associate.
RAM	Ramada	Orthic Black	Carroll	Carroll	The typical or dominant, well drained, clay loam textured Black associate of the Carroll Association.
SCK	Stockton	Orthic Black	Stockton	Stockton	The same as the dominant, well drained, loamy sand textured Black associate of the Stockton Association.
SEE	Sewell	Rego Humic Gleysol	Stockton	Stockton	The same as the poorly drained Meadow associate of the Stockton Association.

Table 10. Cont'd

Soil Symbol	Present Soil Series Name	Subgroup	Soil Association or Associate Carberry Map Sheet (1957)	Soil Association or Associate South-Central Map Sheet (1943)	Remarks
SHX	Shilox	Orthic Regosol	Stockton (Sand Dunes)	Sand Dunes	A major inclusion in the Stockton Association of the Carberry Map and the same as the excessively drained, regosolic Stockton sand dunes. The dominant associate in the Sand Dunes of the South-Central Map.
TDP	Tadpole	Rego Humic Gleysol	Carroll	Carroll	The same as the poorly drained, clay loam, Meadow associate of the Carroll Association.
WHL	Wheatland	Orthic Black	Miniota	Marringhurst, Agassiz	The dominant, well drained, Black associate of the Miniota sands in the Carberry Map. An inclusion in the Marringhurst and Agassiz Associations of the Carberry sheet, equal to the Blackearth associate with a sandy surface over sand and gravel.
WWD	Wellwood	Orthic Black	Wellwood	Glenboro	The dominant, well drained Black associate of the Wellwood clay loam in the Carberry Map. Equivalent to the dominant well drained, Blackearth associate of the Glenboro clay loam, Glenboro Association, in the S.C. map.

Appendix E

GUIDES FOR EVALUATING SOIL SUITABILITY FOR SELECTED USES

Table 11. Land Classification Standards for Irrigation Suitability.

Land Characteristics	Subclass	Class 1 - Very Good	Class 2 - Good	Class 3 - Fair	Class 4 - Poor
SOILS	S				
Texture					
very coarse textured very fine textured		v Fine sandy loams to h clay loams	Loamy fine sand to light clay	Sand to permeable clay	Gravel to clay
Water holding capacity					
low available moisture capacity		q 40 to 60 sat. % >15cm storage in 1.2m <10cm/hr. hydraulic cond.	35 to 65 sat. % >12.5cm storage in 1.2m <12.5cm/hr. hydraulic cond.	25 to 75 sat. % >7.5cm storage in 1.2m <17.5cm/hr. hydraulic cond.	<25 or >75 sat. % <7.5cm storage in 1.2m >17.5cm/hr. hydraulic cond.
Geological Deposit					
shallow deposit over sand or gravel		k .9m or more of fine sandy loam or heavier	.6m or more of fine sandy loam or heavier, or .75m plus of loamy fine sand or sandy loam	.5m or more of sandy loam or heavier, or .6m plus of loamy sand	<.5m of sandy loam or heavier, or .6m of loamy sand or sand
shallow deposit over impervious substrata		b >3m of permeable material	>2m of permeable material	>1m of permeable material	<1m of permeable material
Salinity and Alkalinity[1,2]		a <4 ms/cm in 0-.6m <8 ms/cm below .6m <6 S.A.R.	<4 ms/cm in 0-.6m <12 ms/cm below .6m <8 S.A.R.	<8 ms/cm in 0-.6m <15 ms/cm below .6m <12 S.A.R.	>8 ms/cm in 0-.6m >15 ms/cm below .6m >12 S.A.R.
EXTERNAL FEATURES					
Stones - rock clearing		r None to light clearing	Light to medium clearing	Light to heavy clearing	Excessively stony
Topography	T	g <1% and 0.1% in general gradient (0-3% slope)	<3% in general gradient (3-5% slope)	<5% in general gradient (5-10% slope)	>5% in general* gradient (>10% slope)**
Slope excess gradient					
DRAINAGE	D				
restricted outlet		No problem anticipated	Moderate drainage problem anticipated but may be improved at relatively low cost	Moderate to severe drainage problem anticipated but may be improved by expensive but feasible measures	Drainage improvement not considered feasible
water table		below 2.4m most of year	could be above 1.5m for a short period, then recedes to 2.4m or lower	within 1.5m most of year	within 1m most of year

* Criteria for gravity (flood) irrigation requirements.

** Estimated adjustments to slope criteria for overhead or sprinkler type irrigation methods.

1 If sufficient gypsum is present in the soil, the S.A.R. may be lowered by leaching the soil (a very slow process), and the hydraulic conductivity may then improve.

2 The degree of salinity may vary widely within short distances, and there may be no clear indication of the area occupied by each salinity class. Unless a very detailed mapping and sampling program is carried out, it is impossible to estimate the acreage occupied by each salinity class.

Table 12. Guide for assessing soil suitability as source of topsoil.

The term "topsoil" includes soil materials used to cover barren surfaces exposed during construction, and materials used to improve soil conditions on lawns, gardens, flower beds, etc. The factors to be considered include not only the characteristics of the soil itself, but also the ease or difficulty of excavation, and where removal of topsoil is involved, accessibility to the site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2]	Very friable, friable	Loose, firm	Very firm	Cemented
i	Flooding	None	May flood occasionally for short periods	Frequent flooding	Constantly flooded
w	Wetness[2]	Wetness is not determining if better than very poorly drained.			Very poorly drained and permanently wet soils
t	Slope	0-5%	5-9%	9-15%	>15%
p	Stoniness[2]	Stones 10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones 0.1 m apart (Class 5)
c	Coarse fragments[2]: percent, by volume	<3%	3-15%	15-35%	>35%
s	Texture[2]	FSL, VFSL, L, SiL, SL, SC if 1:1 clay is dominant	CL, SCL, SiCL, SC if 2:1 clay is dominant; c and sic if 1:1 clay is dominant	S, LS, C and SiC if 2:1 clay is dominant. organic soils[3]	Marl, diatomaceous earth
b	Depth of Topsoil[4]	>40 cm	15-40 cm	8-15 cm	<8 cm
n	Salinity of Topsoil[5]	E.C. 0-1	E.C. 1-4	E.C. 4-8	E.C. >8

1/ The symbols are used to indicate the nature of the limitation.

2/ For an explanation of texture, consistence, stoniness, coarse fragments and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

3/ Non-woody organic materials are assessed as good sources for topsoil if mixed with or incorporated into mineral soil.

4/ The remaining soil material (at least 8 cm) must be reclaimable after the uppermost soil is removed.

5/ E.C. = Electrical Conductivity (millisiemens/cm).

Table 13 Guide for assessing soil suitability as source of sand and gravel.

The purpose of this table is to provide guidance for assessing the probable supply as well as quality of the sand or gravel for use as road base material and in concrete. The interpretation pertains mainly to the characteristics of the soil substratum to a depth of 150 cm, augmented by observations made in deep cuts as well as geological knowledge where available.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	Unified Soil Group	SW SP GW GP	SW-SM SP-SM GP-GM GW-GM	SM SW-SC SP-SC GM GP-GC GW-GC	All other groups and bedrock
h	Depth to Seasonal Water Table	Not class determining if deeper than 50 cm		50 cm	
q	Depth to Sand and Gravel	<25 cm	25-75 cm[2]	>75 cm[2]	
p	Stoniness[3]	Not class determining if stones >.5 m apart (Class 0, 1, 2 and 3)		Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
d	Depth to Bedrock	>100 cm	50-100 cm	<50 cm	

[1] The symbols are used to indicate the nature of the limitation.

[2] Rated good if it is known that the underlying gravel or sand deposit is thick (>100 cm).

[3] For an explanation of stoniness and rockiness, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

Table 14. Guide for assessing soil suitability as source of roadfill.

Fill material for buildings or roads are included in this use. The performance of the material when removed from its original location and placed under load at the building site or road bed are to be considered. Since surface materials are generally removed during road or building construction their properties are disregarded. Aside from this layer, the whole soil to a depth of 150-200 cm should be evaluated. Soil materials which are suitable for fill can be considered equally suited for road subgrade construction.

Symbol[1]	Items Affecting Use[2]	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
s	Subgrade[3]				
	a. AASHO group index[4]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[5] and SC[5]	CL (with P.I.[6] <15) and ML	CL (with P.I.[6] of 15 or more), CH and MH[7]	OL, OH and Pt
l	Shrink-swell potential	Low	Moderate	High	
f	Susceptibility to frost action[8]	Low	Moderate	High	
t	Slope	0-15%	15-30%	30-45%	>45%
p	Stoniness[9]	Stones >2 m apart (Class 0, 1 and 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[9]	Rock exposures >35 m apart and cover <10% of the surface	Rock exposure 10-35 m apart and cover 10-25% of the surface	Rock exposure 3.5-10 m apart and cover 25-50% of the surface	Rock exposures <3.5 m apart and cover 50-90% of the surface
w	Wetness[9]	Excessively drained to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
d	Depth to Bedrock	>100 cm	50-100 cm	20-50 cm	<20 cm
h	Depth to Seasonal Water Table	>150 cm	75-150 cm	50-75 cm	<50 cm

1/ The symbols are used to indicate the nature of the limitation.

2/ The first three items pertain to soil after it is placed in a fill; the last six items pertain to soil in its natural condition before excavation for road fill.

3/ This item estimates the strength of the soil material, that is, its ability to withstand applied loads.

4/ Use AASHO group index only where laboratory data are available for the kind of soil being rated; otherwise, use Unified soil groups.

5/ Downgrade suitability rating to fair if content of fines is more than about 30 percent.

6/ P.I. means plasticity index.

7/ Upgrade suitability rating to fair if MH is largely kaolinitic, friable, and free of mica.

8/ Use this item only where frost penetrates below the paved or hardened surface layer and where moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front.

9/ For an explanation of stoniness, rockiness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

Table 15. Guide for assessing soil suitability for permanent buildings[1].

This guide applies to undisturbed soils to be evaluated for single-family dwellings and other structures with similar foundation requirements. The emphasis for rating soils for buildings is on foundation requirements; but soil slope, susceptibility to flooding and other hydrologic conditions, such as wetness, that have effects beyond those related exclusively to foundations are considered too. Also considered are soil properties, particularly depth to bedrock, which influence excavation and construction costs for the building itself and for the installation of utility lines. Excluded are limitations for soil corrosivity, landscaping and septic tank absorption fields.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability[3]			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[4]	With Basements: Very rapidly, rapidly and well drained. Without Basements: Very rapidly, rapidly, well and moderately well drained.	With Basements: Moderately well drained. Without Basements: Imperfectly drained.	With Basements: Imperfectly, poorly, and very poorly drained. Without Basements: Poorly and very poorly drained.	With Basements: Permanently wet soils. Without Basements: Permanently wet soils.
h	Depth to Seasonal Water Table	With Basements: >150 cm Without Basements: >75 cm	With Basements: 75-150 cm Without Basements: 50-75 cm	With Basements: 25-75 cm Without Basements: 25-50 cm	With Basements: <25 cm Without Basements: <25 cm
i	Flooding	None	None	Occasional flooding (once in 5 years)	Frequent flooding (every year)
t	Slope[5]	0-9%	9-15%	15-30%	>30%
s	Subgrade[6]				
	a. AASHO group index[7]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM and GC and SC	CL (with P.I.[8] <15) and ML	CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and Pt
f	Potential Frost Action[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[4]	Stones >10 m apart (Class 0 to 1)	Stones 2-10 m apart (Class 2[10])	Stones 0.1-2 m apart (Class 3[10] to 4)	Stones <0.1 m apart (Class 5[10])
r	Rockiness[4],[11]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to allow location of permanent buildings
d	Depth to Bedrock[11]	With Basements: >150 cm Without Basements: >100 cm	With Basements: 100-150 cm Without Basements: 50-100 cm	With Basements: 50-100 cm Without Basements: <50 cm	With Basements: <50 cm

1/ By halving the slope limits, this table can be used for evaluating soil suitability for buildings with large floor areas, but with foundation requirements not exceeding those of ordinary three-storey dwellings.

2/ The symbols are used to indicate the nature of the limitation.

3/ Some soils assessed as fair or poor may be good sites from an aesthetic or use standpoint, but they will require more site preparation and/or maintenance.

4/ For an explanation of rockiness, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Reduce the slope limits by one half for those soils subject to hillside slippage.

6/ This item estimates the strength of the soil, that is, its ability to withstand applied loads. When available, AASHO Group Index values from laboratory tests were used; otherwise the estimated Unified classes were used.

7/ Group index values were estimated from information published by the Portland Cement Association (PCA, 1962), pp. 23-25.

8/ P.I. means plasticity index.

9/ Frost heave only applies where frost penetrates to the assumed depth of the footings and the soil is moist. The potential frost action classes are taken from the United States Army Corps of Engineers (1961), pp. 5-8.

10/ Rate one class better for buildings without basements.

11/ Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment such as backhoes.

Table 16. Guide for assessing soil suitability for local roads and streets[1].

This guide applies to soils to be evaluated for construction and maintenance of local roads and streets. These are improved roads and streets having some kind of all-weather surfacing, commonly asphalt or concrete, and are expected to carry automobile traffic all year. They consist of: (1) the underlying local soil material (either cut or fill) called the subgrade; (2) the base material of gravel, crushed rock, or lime or soil cement stabilized soil called the subbase; and (3) the actual road surface or pavement, either flexible or rigid. They also are graded to shed water and have ordinary provisions for drainage. With the probable exception of the hardened surface layer, the roads and streets are built mainly from the soil at hand, and cuts and fills are limited, usually less than 2 meters. Excluded from consideration in this guide are highways designed for fast-moving, heavy trucks.

Properties that affect design and construction of roads and streets are: (1) those that affect the load supporting capacity and stability of the subgrade, and (2) those that affect the workability and amount of cut and fill. The AASHO and Unified Classification give an indication of the traffic supporting capacity. Wetness and flooding affect stability. Slope, depth of hardrock, stoniness, rockiness, and wetness affect the ease of excavation and the amount of cut and fill to reach an even grade.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[3]	Very rapidly, rapidly, well and moderately well drained	Imperfectly drained	Poorly and very poorly drained	Permanently wet soils
i	Flooding	None	Infrequent (once in 5 years)	Occasional (once in 2-4 years)	Frequent (every year)
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Bedrock[4]	>100 cm	50-100 cm	<50 cm	
s	Subgrade[5]				
	a. AASHO group index[6]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[7] and SC[7]	CL (with P.I.[8] <15) and ML	CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and Pt
f	Susceptibility to Frost Heave[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[3]	Stones >2 m apart (Class 0 to 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[3]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to permit location of roads and streets

1/ These guidelines, with some adjustment of slope and rockiness limits, will also be useful for assessing soils for use as parking lots.

2/ Symbols are used to indicate the nature of the limitation.

3/ For an explanation of stoniness, rockiness and soil drainage classes, see the Canada Soil Information System (Canada Soil Survey Committee, 1978).

4/ Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment and is rippable by machinery.

5/ This item estimates the strength of soil materials as it applies to roadbeds. When available, AASHO Group Index values from laboratory tests were used; otherwise, the estimated Unified classes were used. The limitations were estimated assuming that the roads would be surfaced. On unsurfaced roads, rapidly drained, very sandy, poorly graded soils may cause washboard or rough roads.

6/ Group index values were estimated from information published by the Portland Cement Association (PCA, 1962) pp. 23-25.

7/ Downgrade to moderate if content of fines (less than 200 mesh) is greater than about 30 percent.

8/ P.I. means plasticity index.

9/ Frost heave is important where frost penetrates below the paved or hardened surface layer and moisture transportable by capillary movement is sufficient to form ice lenses at the freezing point. The susceptibility classes are taken from the United States Army Corps of Engineers (1962) pp. 5-8.

Table 17. Guide for assessing soil suitability for trench-type sanitary landfills[1/].

The trench-type sanitary landfill is a sanitary landfill, in which dry garbage and trash is buried daily in an open trench and covered with a layer of soil material. Suitability of the site is dependent upon the potential for pollution of water sources through groundwater contact with the refuse, or leachate arising from the site. Those properties affecting ease of excavation of the site must be supplemented with geological and hydrological knowledge to provide subsurface soil and groundwater data to a depth of at least 3 to 4.5 m, a common depth of landfills.

Symbol[2/]	Items Affecting Use	Degree of Soil Suitability			
		Good - G[3/]	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal High Water Table	Not class determining if more than 180 cm		100-180 cm	<100 cm
w	Wetness[4/]	Not class determining if better than imperfectly drained		Imperfectly drained	Poorly and very poorly drained or permanently wet soils
i	Flooding	None	Rare	Occasional	Frequent
k	Permeability[5/]	<5 cm/hr	<5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-15%	15-30%	30-45%	>45%
s	Soil Texture[4/,6/] (dominant to a depth of 150 cm)	SL, L, SiL, SCL	SiCL[7/], CL, SC, LS	SiC, C	Muck, peat, gravel, sand
d	Depth to Hard Bedrock Rippable	>150 cm >150 cm	>150 cm 100-150 cm	100-150 cm 100-150 cm	<100 cm <100 cm
p	Stoniness[4/]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones <0.1 m apart (Class 5)
r	Nature of Bedrock	Impermeable			Highly permeable, fractured, easily soluble

1/ Based on soil depth (120 cm) commonly investigated in making soil surveys.

2/ The symbols are used to indicate the nature of the limitation.

3/ If probability is high that the soil material to a depth of 3 to 4.5 m will not alter a rating of good or fair, indicate this by an appropriate footnote, such as "Probably good to a depth of 3.5 m", or "Probably fair to a depth of 3.5 m".

4/ For an explanation of stoniness, texture and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Reflects ability of soil to retard movement of leachate from the landfills; may not reflect a limitation in arid and semiarid areas.

6/ Reflects ease of digging and moving (workability) and trafficability in the immediate area of the trench where there may not be surfaced roads.

7/ Soils high in expansive clays may need to be given a suitability rating of poor.

Table 18. Guide for assessing soil suitability for area-type sanitary landfills.

In the area-type sanitary landfill refuse is placed on the surface of the soil in successive layers. The daily and final cover material generally must be imported. A final cover of soil material at least 60 cm thick is placed over the fill when it is completed.

The soil under the proposed site should be investigated so as to determine the probability that leachates from the landfill can penetrate the soil and thereby pollute water supplies.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal Water Table[2]	>150 cm	150-100 cm	50-100 cm	<50 cm
w	Wetness[2],[3]	Rapid to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
f	Flooding	None	Rare	Occasional	Frequent
k	Permeability[4],[5]	Not class determining if less than 5 cm/hr		5-15 cm/hr	>15 cm/hr
t	Slope	0-9%	9-15%	15-30%	>30%

[1] The symbols are used to indicate the nature of the limitation.

[2] Reflects influence of wetness on operation of equipment.

[3] For an explanation of drainage, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[4] Reflects ability of the soil to retard movement of leachate from landfills; may not reflect a limitation in arid and semiarid areas.

[5] Due to possible groundwater contamination, impermeable bedrock is considered poor and permeable bedrock is rated very poor for area-type sanitary landfills.

Table 19. Guide for assessing soil suitability as cover material for area-type sanitary landfills.

The term cover material includes soil materials used to put a daily and final covering layer on refuse in area-type sanitary landfills. This cover material may be derived from the area of the landfill or may be brought in from surrounding areas.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2]	Very friable, friable	Loose, firm	Very firm	Cemented
s	Texture[2],[3]	SL, L, SiL, SCL	SiCL, CL, SC, LS	SiC, C	Muck, peat, sand, gravel
d	Depth to bedrock[4]	>150 cm	100-150 cm	50-100 cm	<50 cm
c	Coarse fragments[2]	<15%	15-35%	>35%	
p	Stoniness[2]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones <0.1 m apart (Class 5)
t	Slope	<9%	9-15%	15-30%	>30%
w	Wetness[2]	Not class determining if better than poorly drained		Poorly drained	Very poorly drained or permanently wet soils

[1] The symbols are used to indicate the nature of the limitation.

[2] For an explanation of consistence, texture, coarse fragments, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Soils having a high proportion of non-expansive clays may be given a suitability rating one class better than is shown for them in this table.

[4] Thickness of material excluding topsoil, which will be stockpiled (see guide for topsoil).

Table 20. Guide for assessing soil suitability for reservoirs and sewage lagoons.

Factors affecting the ability of undisturbed soils to impound water or sewage and prevent seepage are considered for evaluating soils on their suitability for reservoir and lagoon areas. This evaluation considers soil both as a vessel for the impounded area and as material for the enclosing embankment. As the impounded liquids could be potential sources of contamination of nearby water supplies, e.g. sewage lagoons, the landscape position of the reservoir as it affects risk of flooding must also be considered.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Water Table[2]	>150 cm	100-150 cm	50-100 cm	<50 cm
i	Flooding[3]	None	None	Subject to infrequent flooding (once in 50 years)	Subject to frequent high level flooding
k	Soil Permeability	0-0.5 cm/hr	0.5-5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-2%	2-5%	5-9%	>9%
o	Organic Matter	<2%	2-10%	10-30%	>30%
c	Coarse Fragments[4] <25 cm in diameter, % by volume	<20%	20-35%	>35%	
p	Stoniness[4], >25 cm diameter, percent of surface area	<3% (Class 0, 1 and 2)	3-15% (Class 3)	15-50% (Class 4)	>50% (Class 5)
d	Depth to Bedrock[5]	>150 cm	100-150 cm	50-100 cm	<50 cm
j	Thickness of Slowly Permeable Layer	>100 cm	50-100 cm	50-25 cm	<25 cm
a	Subgrade Unified Soil Classes	GC, SC, CL, & CH	GM, ML, SM & MH	SW & SP	OL, OH & Pt GP, GW

1/ The symbols are used to indicate the nature of the limitation.

2/ If the floor of the lagoon has nearly impermeable material at least 50 cm thick, disregard depth to water table.

3/ Disregard flooding if it is not likely to enter or damage the lagoon (flood waters have low velocity and depth less than 150 cm).

4/ For an explanation of coarse fragments and stoniness classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Surface exposures of non rippable rock are rated very poor. If underlying bedrock is impermeable, rating should be one class better.

Table 21. Guide for assessing soil suitability for septic tank absorption fields.

This guide applies to soils to be used as an absorption and filtering medium for effluent from septic tank systems. A subsurface tile system laid in such a way that effluent from the septic tank is distributed reasonably uniformly into the natural soil is assumed when applying this guide. A rating of poor need not mean that a septic system should not be installed in the given soil, but rather, may suggest the difficulty, in terms of installation and maintenance, which can be expected.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
k	Permeability[2]	Rapid to moderately rapid	Moderate	Slow	Very slow
	Percolation Rate[3] (Auger hole method)	About 8-18 min/cm[3]	18-24 min/cm	Slower than 24 min/cm	
h	Depth to Seasonal Water Table[4]	>150 cm[5]	100-150 cm	50-100 cm	<50 cm
i	Flooding	Not subject to flooding	Not subject to flooding	Subject to occasional flooding (once in 5 years)	Floods every year
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Hard Rock, bedrock or other impervious materials	>150 cm	100-150 cm[6]	50-100 cm	<50 cm

1/ The symbols are used to indicate the nature of the limitation.

2/ The suitability ratings should be related to the permeability of soil layers at and below depth of the tile line.

3/ Soils having a percolation rate less than about 8 min/cm are likely to present a pollution hazard to adjacent waters. This hazard must be noted, but the degree of hazard must, in each case, be assessed by examining the proximity of the proposed installation to water bodies, water table, and related features. The symbol g is used to indicate this condition. Refer to U.S. Dept. of Health, Education and Welfare (1969) for details of this procedure.

4/ Seasonal means for more than one month. It may, with caution, be possible to make some adjustment for the severity of a water table limitation in those cases where seasonal use of the facility does not coincide with the period of high water table.

5/ A seasonal water table should be at least 100 cm below the bottom of the trench at all times for soils rated Good (U.S. Dept. of Health, Education and Welfare, 1969). The depths used to water table are based on an assumed tile depth of 50 cm. Where relief permits, the effective depth above a water table or rock can be increased by adding appropriate amounts of fill.

6/ Where the slope is greater than 9%, a depth to bedrock of 100-150 cm is assessed as poor.

Table 22. Guide for assessing soil suitability for playgrounds.

This guide applies to soils to be used intensively for playgrounds for baseball, football, badminton, and for other similar organized games. These areas are subject to intensive foot traffic. A nearly level surface, good drainage, and a soil texture and consistence that gives a firm surface generally are required. The most desirable soils are free of rock outcrops and coarse fragments.

Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Rapidly, well and moderately well drained soils with no ponding or seepage. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding of short duration and imperfectly drained soils. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding, and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	Occasional flooding. May flood once every 2-3 years during season of use.	Floods every year during season of use.	Prolonged flooding during season of use.
k	Permeability	Very rapid to moderate.	Moderately slow and slow.	Very slow.	
t	Slope	0-2%	2-5%	5-9%	>9%
d	Depth to Bedrock	>100 cm	50-100 cm[3]	<50 cm[3]	
c	Coarse fragments on surface[2]	Relatively free of coarse fragments.	<20% coarse fragments.	>20% coarse fragments.	
p	Stoniness[2]	Stones >10 m apart. (Class 0 to 1)	Stones 2-10 m apart. (Class 2)	Stones 0.1-2 m apart. (Class 3, 4)	Stones <0.1 m apart. (Class 5)
r	Rockiness[2]	Rock exposures >100 m apart and cover <2% of the surface.	Rock exposures 30-100 m apart and cover about 2-10% of the surface.	Rock exposures <30 m apart and cover >10% of the surface.	Rock outcrops too frequent to permit playground location.
s	Surface Soil Texture[2],[4]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS	SC, SiC, C[5]; S, Si	Peaty soils; S and LS subject to blowing.
q	Depth to Sand or Gravel[6]	>100 cm	50-100 cm	<50 cm	
m	Useful Moisture[7]	Water storage capacity[8] >15.0 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

1/ The symbols are used to indicate the nature of the limitation.

2/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

3/ Coarse fragments for the purpose of this table include gravels and cobbles.

4/ Downgrade to a very poor suitability rating if the slope is greater than 5%.

5/ Surface soil texture influences soil ratings as it affects foot trafficability, surface wetness, dust, and maintenance. Adverse soil textures may be partially or completely overcome with the addition of topsoil.

6/ Moderately well and well drained SC, SiC and C soils may be rated fair.

7/ Depth to sand or gravel is considered a limitation in that levelling operations may expose sand or gravel, thereby bringing about adverse surface textures and undesirable amounts of coarse fragments. The addition of topsoil after the levelling process would overcome this limitation.

8/ This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

9/ Consult glossary for definitions of terms used.

Table 23 Guide for assessing soil suitability for picnic areas.

This guide applies to soils considered for intensive use as park-type picnic areas. It is assumed that most vehicular traffic will be confined to the access roads. Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Very rapidly, rapidly, well and moderately well drained soils not subject to seepage or ponding. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils not subject to ponding or seepage. Water Table above 50 cm for short periods during season of use.	Imperfectly drained soils subject to seepage or ponding. Poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	May flood 1 or 2 times per year for short periods during season of use.	Floods more than 2 times during season of use.	Prolonged flooding during season of use.
t	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture[2,3]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[4]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2]	0-20%	20-50%	>50%	
p	Stoniness[2]	Stones >2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[2,5,6]	Rock exposures roughly 30-100 or more m apart and cover <10% of the surface.	Rock exposures roughly 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of picnic areas.
m	Useful Moisture[7]	Water storage capacity[8] >15 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

1/ The symbols are used to indicate the nature of the limitation.

2/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978). Coarse fragments for the purpose of this table, include gravels and cobbles. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

3/ Surface soil texture influences soil ratings as it affects foot trafficability, dust and soil permeability.

4/ Moderately well and well drained SC, SiC and C soils may be rated fair.

5/ Very shallow soils are rated as having severe or very severe limitations for stoniness or rockiness.

6/ The nature and topography of the bedrock exposures may significantly alter these ratings. As such, on-site investigations will be necessary in map units containing bedrock when these are considered as possible sites.

7/ This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

8/ Consult glossary for definitions of terms used.

Table 24. Guide for assessing soil suitability for camp areas.

This guide applies to soils to be used intensively for tents and camp trailers and the accompanying activities of outdoor living. It is assumed that little site preparation will be done other than shaping and levelling for campsites and parking areas. The soil should be suitable for heavy foot traffic by humans and limited vehicular traffic. Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the final evaluation of site.

Back country campsites differ in design, setting and management but require similar soil attributes. These guides should apply to evaluations for back country campsites but depending on the nature of the facility the interpreter may wish to adjust the criteria defining a given degree of limitation to reflect the changed requirement. For example, small tentsites may allow rock exposures greater than 10 m apart to be considered a slight limitation.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Very rapidly, rapidly, well and moderately well drained soils with no seepage or ponding. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils with no seepage or ponding. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None	Very occasional flooding during season of use. Once in 5-10 years.	Occasional flooding during season of use. Once in 2-4 years.	Flooding during every season of use.
k	Permeability	Very rapid to moderate inclusive.	Moderately slow and slow.	Very slow.	
t	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture[2],[3]	SL, FSL, VFSL, L	SiL, SCL, CL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[4]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2],[5]	0-20%	20-50%	>50%	
p	Stoniness[2],[6]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
r	Rockiness[2],[6]	No rock exposures	Rock exposures >10 m apart and cover <25% of the area.	Rock exposures <10 m apart and cover >25% of the area.	Rock exposures too frequent to permit campground location.

[1] The symbols are used to indicate the nature of the limitation.

[2] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Surface soil texture influences soil ratings as it affects foot trafficability, dust, and soil permeability.

[4] Moderately well and well drained SC, SiC and C soils may be rated fair.

[5] Coarse fragments for the purpose of this table include gravels and cobbles. Some gravelly soils may be rated as having slight limitations if the content of gravel exceeds 20% by only a small margin, providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

[6] Very shallow soils are rated as having a limitation for rockiness and/or stoniness.

Table 25. Guide for assessing soil suitability for paths and trails.

It is assumed that the trails will be built at least 45 cm wide and that obstructions such as cobbles and stones will be removed during construction. It is also assumed that a dry, stable tread is desirable and that muddy, dusty, worn or eroded trail treads are undesirable. Hiking and riding trails are not treated separately, but as the design requirements for riding trails are more stringent, a given limitation will be more difficult to overcome. Poor or very poor suitability does not indicate that a trail cannot or should not be built. It does, however, suggest higher design requirements and maintenance to overcome the limitations.

Symbol[1]	Items[2] Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
s	Texture[3],[4]	SL, FSL, VFSL, LS, L	SiL, CL, SiCL, SCL	SC, SiC, C[5]; Sand, Si	Peaty soils; loose sand subject to blowing
c	Coarse Fragment Content[4],[6]	0-20%	20-50%	>50%	
p	Stoniness[4]	Stones >2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
w	Wetness[4]	Very rapidly, rapidly well, and moderately well drained soils. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage and ponding and imperfectly drained soils. Water table may be above 50 cm for short periods during season of use.	Poorly and very poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Permanently wet soils.
r	Rockiness[4],[7]	Rock exposures >30 m apart and cover <10% of the surface.	Rock exposures 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of paths and trails.
t	Slope[8]	0-15%	15-30%	30-60%	>60%
i	Flooding	Not subject to flooding during season of use.	Floods 1 or 2 times during season of use.	Floods more than 2 times during season of use.	Subject to prolonged flooding during season of use.

1/ The symbols are used to indicate the nature of the limitation.

2/ The items affecting use listed in this table are those which have been shown to cause significant differences in trail response. Elevation, aspect, position on slope, and snow avalanching may have slight effects or influence trail management and should be considered in the final site evaluation. Items such as vegetation, fauna, and scenic value are not considered in the guidelines (Epp, 1977).

3/ Texture refers to the soil texture which will form the tread texture. This is the surface texture on level areas but may be a subsurface texture on slopes. Textural classes are based on the less than 2 mm soil fraction. Texture influences soil ratings as it influences foot trafficability, dust, design or maintenance of trails, and erosion hazards.

4/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Moderately well and well drained SC, SiC and C soils may be rated fair.

6/ Coarse fragments for the purpose of this table, include gravels and cobbles. Gravels tend to cause unstable footing when present in high amounts, and are also associated with increased erosion. Cobbles (and stones) must be removed from the trail tread, increasing construction and maintenance difficulties. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix or (b) the fragments are less than 2 cm in size.

7/ The type of rock outcrop (flat lying vs cliffs), and the orientation of the structure (linear cliffs vs massive blocks) can greatly alter the degree of the limitation. Each site with a Rockiness limitation based on the percent rock outcrop above should be evaluated on its own merits and the degree of limitation should then be modified appropriately if necessary.

8/ Slope in this context refers to the slope of the ground surface, not the slope of the tread.

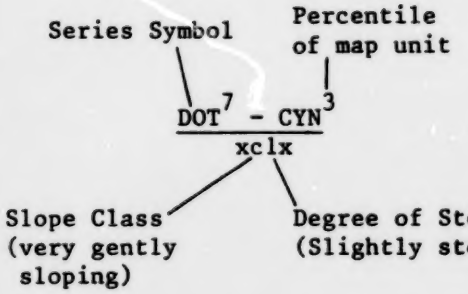
Soil Legend for SOUTH ASSINIBOINE

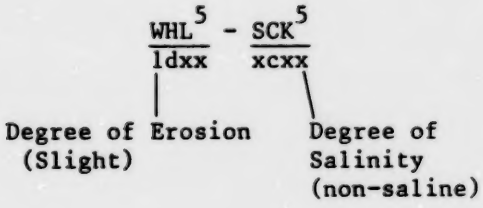
Soil Symbol	Soil Name	Surface Texture	Soil Drainage	Mode of Deposition	Family Particle Size	Subgroup
AIZ	Arizona	LFS	WELL	Lacustrine	Sandy	O.R
BKR	Basker	SICL	POOR	Fluvial	Loamy	R.HG
CAV	Carvey	CL	POOR	Lacustrine/Fluvial	Loamy/Sandy Skeletal	R.HG
CKD	Crookdale	CL	IMPER	Lacustrine	Fine Loamy/Sandy	GLR.BL
CYN	Croyon	L-CL	WELL	Lacustrine/Fluvial	Loamy/Sandy Skeletal	O.BL
CXT	Capell	CL	IMPER	Lacustrine/Fluvial	Loamy/Sandy Skeletal	GLR.BL
CXV	Charman	CL	IMPER	Lacustrine	Fine Loamy	GL.BL
DOT	Dorset	LS	WELL	Fluvial	Sandy Skeletal	O.BL
DXM	Druxman	L	IMPER	Lacustrine/Fluvial	Loamy/Sandy Skeletal	GL.BL
ERX	Eroded Slope Complex	Var.	WELL-IMP		Variable	
GBO	Glenboro	L	WELL	Lacustrine	Loamy/Sandy	O.BL
GRO	Grover	L	IMPER	Lacustrine	Loamy/Sandy	GLR.BL
HMO	Hummerston	LFS	IMPER	Lacustrine	Sandy	GLR.BL
HRG	Harding	C	IMPER	Lacustrine	Clayey	GL.BL
JIK	Janick	C	WELL	Lacustrine	Clayey	O.BL
LEI	Levine	SICL	IMPER	Fluvial	Loamy	GLCU.R
LVH	Lavenham	LFS	IMPER	Lacustrine	Sandy	GL.BL
MOW	Mowbray	SiCL	WELL	Fluvial	Loamy	CU.R.
MXI	Miniota	SL	WELL	Lacustrine/Fluvial	Coarse Loamy/Sandy Skeletal	O.BL
OBR	Oberon	CL	IMPER	Lacustrine	Fine Loamy/Sandy	GL.BL
PDA	Prodan	CL	IMPER	Lacustrine	Fine Loamy	GLR.BL
RAM	Ramada	CL	WELL	Lacustrine	Fine Loamy	O.BL
SCK	Stockton	LFS	WELL	Lacustrine	Sandy	O.BL
SEE	Sewell	LFS	POOR	Lacustrine	Sandy	R.HG
SHX	Shilox	FS	WELL	Eolian	Sandy	O.R
TDP	Tadpole	CL	POOR	Lacustrine	Fine Loamy	R.HG
WHL	Wheatland	LS	WELL	Lacustrine/Fluvial	Sandy/Sandy Skeletal	O.BL
WWD	Wellwood	CL	WELL	Lacustrine	Fine Loamy/Sandy	O.BL

Appendix G

MAP UNIT SYMBOLOGY

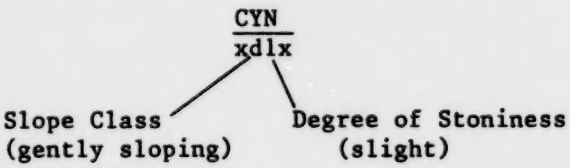
Compound Map Units

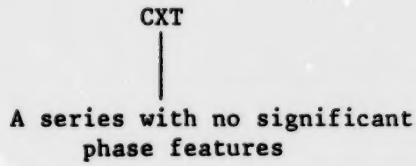




In a compound unit where two series share the same denominator, the phases apply to both series accordingly.

Simple Map Units





Phases

Degree of Erosion

x	non-eroded or minimal
1	slightly eroded
2	moderately eroded
3	severely eroded
o	overblown

Slope Class

x	0-2%	level to nearly level
c	2-5%	very gently sloping
d	5-9%	gently sloping
e	9-15%	moderately sloping
f	15-30%	strongly sloping
g	30-45%	very strongly sloping
h	45-70%	extremely sloping

Stoniness

x	non-stony
1	slightly stony
2	moderately stony
3	very stony
4	exceedingly stony
5	excessively stony

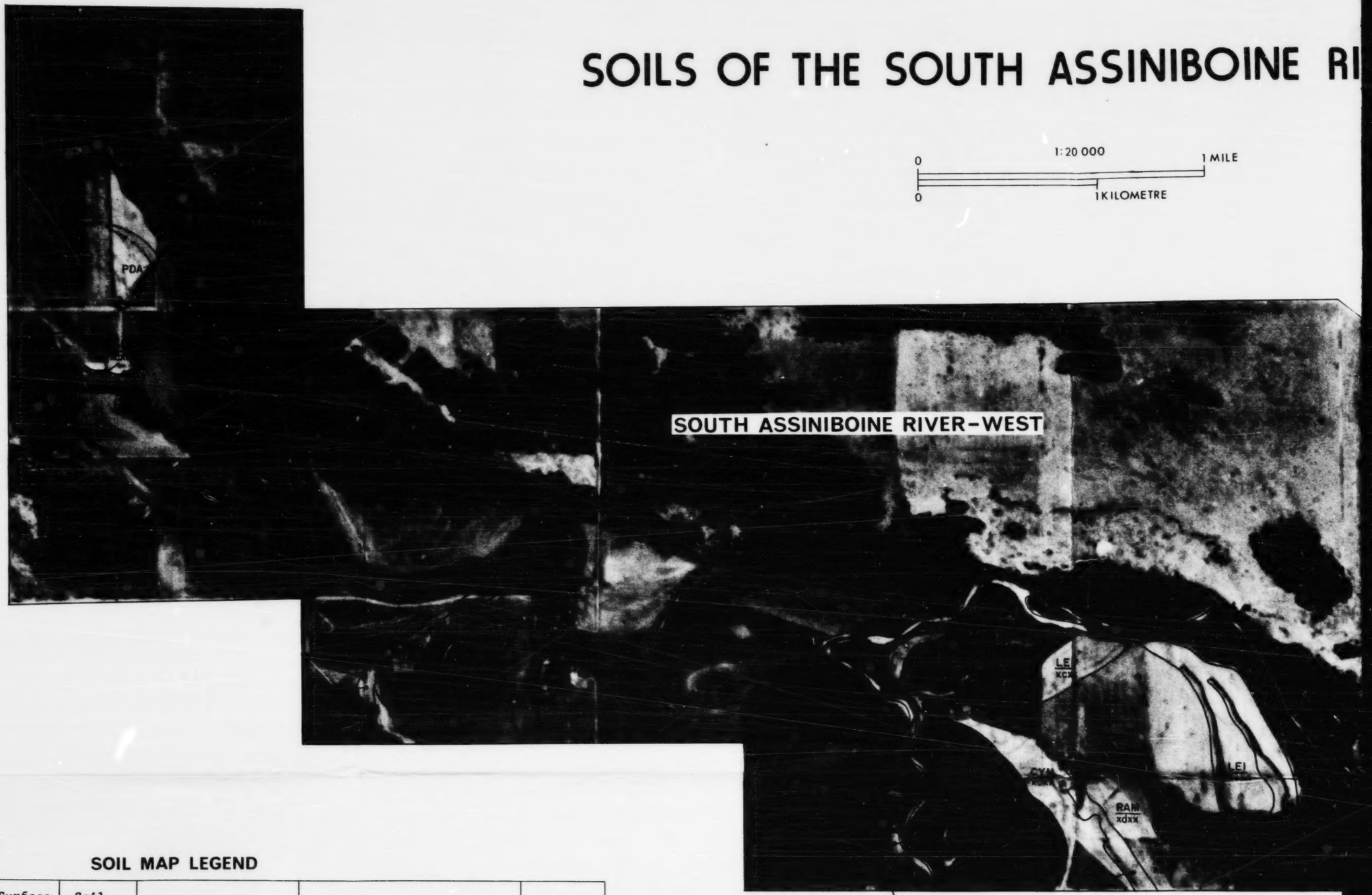
Degree of Salinity		Cond. mS/cm
x	non-saline	0-4
s	weakly saline	4-8
t	moderately saline	8-15
u	strongly saline	15+

SOILS OF THE SOUTH ASSINIBOINE RI

1:20 000

0 1 MILE

0 1 KILOMETRE



R.16W

SOIL MAP LEGEND

Soil Symbol	Soil Name	Surface Texture	Soil Drainage	Mode of Deposition	Family Particle Size	Subgroup
AIZ	Arizona	LFS	WELL	Lacustrine	Sandy	O.R
BKR	Basker	SICL	POOR	Fluvial	Loamy	R.HG
CAV	Carvey	CL	POOR	Lacustrine/Fluvial	Loamy/Sandy Skeletal	R.HG
CKD	Crookdale	CL	IMPER	Lacustrine	Fine Loamy/Sandy	GLR.BL
CYN	Croyon	L-CL	WELL	Lacustrine/Fluvial	Loamy/Sandy Skeletal	O.BL
CXT	Capell	CL	IMPER	Lacustrine/Fluvial	Loamy/Sandy Skeletal	GLR.BL

31 30 33 34 35 36

F THE SOUTH ASSINIBOINE RIVER AREA

1:20 000

0 1 MILE

0 1 KILOMETRE

R.16W

SOIL MAP LEGEND

Soil Symbol	Soil Name	Surface Texture	Soil Drainage	Mode of Deposition	Family Particle Size	Subgroup
AIZ	Arizona	LFS	WELL	Lacustrine	Sandy	O.R
BKR	Basker	SICL	POOR	Fluvial	Loamy	R.HG
CAV	Carvey	CL	POOR	Lacustrine/Fluvial	Loamy/Sandy Skeletal	R.HG
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CXT	Capell	CL	IMPER	Lacustrine/Fluvial	Loamy/Sandy Skeletal	GLR.BL
CXV	Charman	CL	IMPER	Lacustrine	Fine Loamy	GL.BL
DOT	Dorset	LS	WELL	Fluvial	Sandy Skeletal	O.BL
DXM	Druxman	L	IMPER	Lacustrine/Fluvial	Loamy/Sandy Skeletal	GL.BL
ERX	Eroded Slope Complex	Var.	WELL-IMP		Variable	
GBO	Glenboro	L	WELL	Lacustrine	Loamy/Sandy	O.BL
GRO	Grover	L	IMPER	Lacustrine	Loamy/Sandy	GLR.BL
HMO	Hummerston	LFS	IMPER	Lacustrine	Sandy	GLR.BL
HRG	Harding	C	IMPER	Lacustrine	Clayey	GL.BL
JIK	Janick	C	WELL	Lacustrine	Clayey	O.BL
LEI	Levine	SICL	IMPER	Fluvial	Loamy	GLCU.R
LVH	Lavenham	LFS	IMPER	Lacustrine	Sandy	GL.BL
MOW	Mowbray	SiCL	WELL	Fluvial	Loamy	CU.R.
MXI	Miniota	SL	WELL	Lacustrine/Fluvial	Coarse Loamy/Sandy Skeletal	O.BL
OBR	Oberon	CL	IMPER	Lacustrine	Fine Loamy/Sandy	GL.BL
PDA	Prodan	CL	IMPER	Lacustrine	Fine Loamy	GLR.BL
RAM	Ramada	CL	WELL	Lacustrine	Fine Loamy	O.BL
SCK	Stockton	LFS	WELL	Lacustrine	Sandy	O.BL
SEE	Sewell	LFS	POOR	Lacustrine	Sandy	R.HG
SHX	Shilox	FS	WELL	Eolian	Sandy	O.R
TDP	Tadpole	CL	POOR	Lacustrine	Fine Loamy	R.HG
WHL	Wheatland	LS	WELL	Lacustrine/Fluvial	Sandy/Sandy Skeletal	O.BL
WWD	Wellwood	CL	WELL	Lacustrine	Fine Loamy/Sandy	O.BL

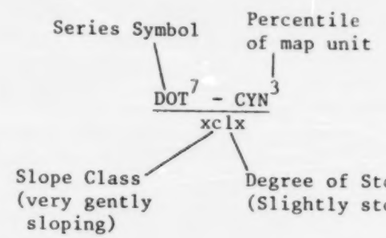
31	32	33	34	35	36
30	29	28	27	26	25
19	20	21	22	23	24
18	17	16	15	14	13
7	8	9	10	11	12
6	5	4	3	2	1

TOWNSHIP DIAGRAM

LOCATION OF STUDY AREA

MAP UNIT SYMBOLOGY

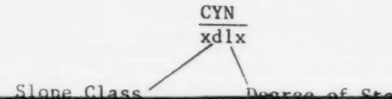
Compound Map Units



Degree of (Slight)

In a compound unit where two series share the same denominator, th
apply to both series accordingly.

Simple Map Units



MAP UNIT SYMBOLOGY

Compound Map Units

Series Symbol — Percentile of map unit

$$\frac{DOT^{7} - CYN^{3}}{xc1x}$$

Slope Class (very gently sloping) — Degree of Stoniness (Slightly stony)

$$\frac{WHL^{5} - SCK^{5}}{1dxx \quad xcxx}$$

Degree of Erosion (Slight) — Degree of Salinity (non-saline)

In a compound unit where two series share the same denominator, the phases apply to both series accordingly.

Simple Map Units

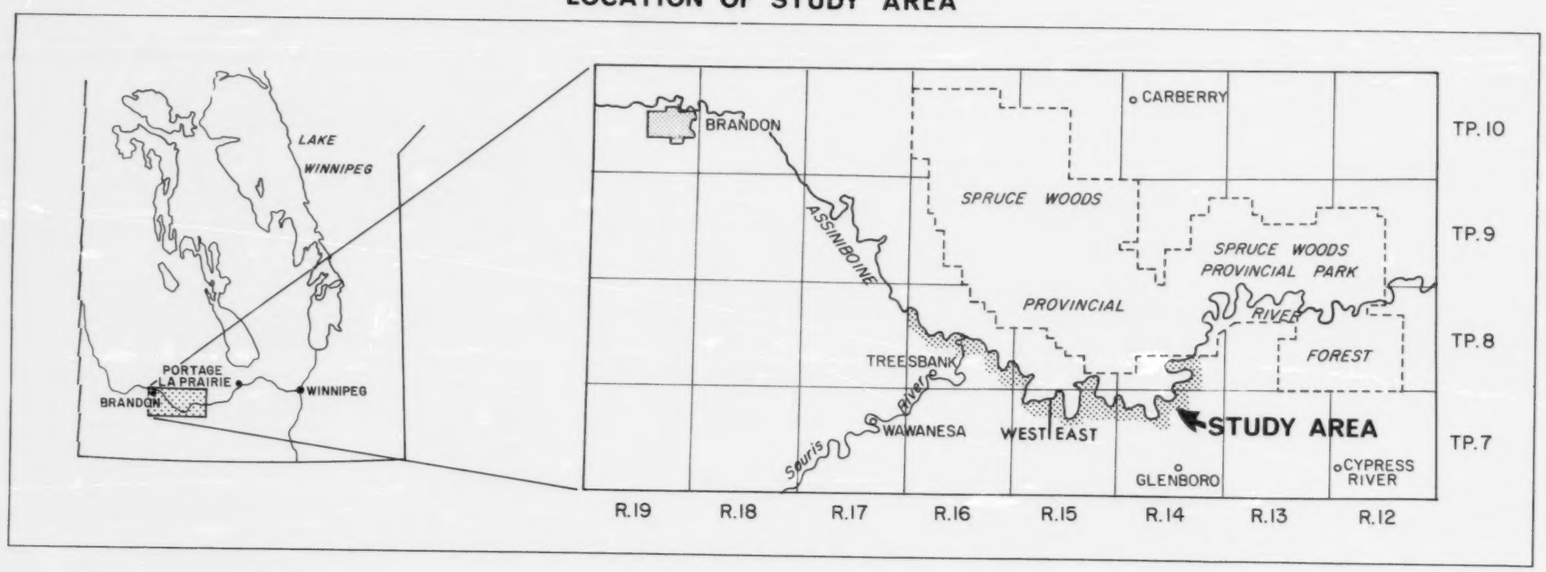
$$\frac{CYN}{xd1x}$$

Slope Class (gently sloping) — Degree of Stoniness (slight)

CXT

A series with no significant phase features

LOCATION OF STUDY AREA



In a compound unit where two series share the same denominator, apply to both series accordingly.

Simple Map Units

CYN
xdlx

Slope Class (gently sloping)

Degree of Stoniness (slight)

CXT

A series wit
phase f

Phases

Degree of Erosion

- x non-eroded or minimal
- 1 slightly eroded
- 2 moderately eroded
- 3 severely eroded
- o overblown

Stoniness

- x non-stony
- 1 slightly ston
- 2 moderately st
- 3 very stony
- 4 exceedingly s
- 5 excessively s

Slope Class

- x 0-2% level to nearly level
- c 2-5% very gently sloping
- d 5-9% gently sloping
- e 9-15% moderately sloping
- f 15-30% strongly sloping
- g 30-45% very strongly sloping
- h 45-70% extremely sloping

Degree of Salini

- x non-saline
- s weakly saline
- t moderately sa
- u strongly sali

SOUTH ASSINIBOINE RIVER

Simple Map Units

CYN
xdlx

Slope Class (gently sloping)

Degree of Stoniness (slight)

CXT

A series with no significant phase features

Phases

Degree of Erosion

- x non-eroded or minimal
- 1 slightly eroded
- 2 moderately eroded
- 3 severely eroded
- o overblown

Slope Class

x	0-2%	level to nearly level
c	2-5%	very gently sloping
d	5-9%	gently sloping
e	9-15%	moderately sloping
f	15-30%	strongly sloping
g	30-45%	very strongly sloping
h	45-70%	extremely sloping

Stoniness

- x non-stony
- 1 slightly stony
- 2 moderately stony
- 3 very stony
- 4 exceedingly stony
- 5 excessively stony

Degree of Salinity		Cond. mS/cm
x	non-saline	0-4
s	weakly saline	4-8
t	moderately saline	8-15
u	strongly saline	15+

TP. 7

TP. 8

R.15W

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REPORT NO. D64

SOUTH ASSINIBOINE RIVER - EAST

TP. 8

TP. 7

R.14W

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REPORT NO. 64